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ANNUAL REPORT

OF THE

SECRETARY OF WAR

FOR

THE YEAR 1882.

IN FOUR VOLUMES.

VOLUME II.

PART 2.

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APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

APPENDIX I.

IMPROVEMENT OF THE HARBORS OF NORFOLK, VA., AND BEAUFORT, N. C.; OF CURRITUCK SOUND, COANJOK BAY, AND NORTH RIVER AND BAR, AND OF CERTAIN RIVERS IN VIRGINIA AND IN NORTH CAROLINA AND SOUTH CAROLINA.

REPORT OF CAPTAIN JAMES MERCUR, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Harbor at Norfolk, Va., and its approaches.
2. Archer's Hope River, Virginia.
3. Pagan Creek, Virginia.
4. Blackwater River, Virginia.
5. Nottaway River, Virginia.
6. North Landing River, Virginia and North Carolina.
7. Currituck Sound, Coanjok Bay, North River and Bar, North Carolina.
8. Scuppernong River, North Carolina.
9. Pamlico and Tar rivers, North Carolina.
10. Neuse River, North Carolina.
11. Trent River, North Carolina.
12. Contentnea Creek, North Carolina.
13. Beaufort Harbor, North Carolina.
14. Cape Fear River between Wilmington and Fayetteville, N. C.
15. Tillington River, North Carolina.
16. Town Creek, North Carolina.
17. Yadkin River, North Carolina.
18. Great Pee Dee River, South Carolina.
19. Waccamaw River, North Carolina and South Carolina.
20. Santee River, South Carolina.
21. Wateree River, South Carolina.

EXAMINATIONS AND SURVEYS.

22. Whiteoak River, North Carolina.
23. Meherrin River, North Carolina.
24. New River, North Carolina.
25. Water line between the Cape Fear and Waccamaw rivers, North Carolina.
26. Bar at mouth of Winyah Bay.
27. Oregon Inlet, North Carolina.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., August 7, 1882.

GENERAL: I have the honor to transmit herewith annual reports upon the works of river and harbor improvement under my charge for the fiscal year ending June 30, 1882.

Very respectfully, your obedient servant.

JAMES MERCUR,
Captain of Engineers.

The CHIEF OF ENGINEERS, *U. S. A.*

I 1.

IMPROVEMENT OF HARBOR AT NORFOLK, VIRGINIA, AND ITS APPROACHES.

The object of this improvement has been fully set forth in previous annual reports, and is, in brief, to secure a channel not less than 25 feet deep and 500 feet wide, at ordinary low-water from the deep water of Hampton Roads to the harbor and the United States navy-yard at Gosport, immediately above, on the south branch of the Elizabeth River, to improve the harbor proper by dredging at the mouth of the eastern branch, and for some distance above, and to dredge off the slopes of the flats at Portsmouth and Berkley in order to restore the cross-sectional area and anchorage grounds, which have been lost during recent years.

For details of the operations of previous years, I respectfully refer to the Annual Reports of the Chief of Engineers for 1878, 1879, 1880, and 1881.

The act of Congress of June 14, 1880, appropriated $50,000 for this work. A project for the expenditure of this sum, having in view the continuance of the general plan of improvement, was approved by the Chief of Engineers.

Proposals were invited for dredging 350,000 cubic yards of material, more or less.

The contract was awarded to Messrs. Pardessus & Anthony, the lowest bidders, at 9½ cents.

Operations were commenced October 8, 1880, and continued, with interruptions from the breaking of machinery and bad weather, until January, 1881, when, finding themselves unable to complete the contract within the required time, June 30, 1881, the contractors obtained assistance from the National Dredging Company, to the general manager of which, Mr. F. B. Colton, they gave power of attorney to collect any money which might become due in the further execution of the contract.

This measure was fully approved and the power of attorney filed with the accounting officer of the Treasury.

These proceedings occasioned delay, and it was not until February 14 that work was resumed, after which it continued under Mr. Colton's management.

The financial embarrassments and other delays had put the work back to such an extent that it became evident that it could not be completed within the time specified.

An extension of four months was asked for and granted, under authority of the Chief of Engineers, of June 21, 1881.

Under this extension operations were continued on the bar at Sewall's Point until September 12, when the quantity required under the specifications having been removed, the contractor stopped work.

There were removed under this contract—

	Cubic yards.
Previous to June 30—	
From Western Branch Bar	14,932
From Sewall's Point Bar	221,883
	236,815
And after June 30—	
From Sewall's Point Bar	119,147
Making in all	355,962

The river and harbor act approved March 3, 1881, appropriated $75,000 for this work.

A project for its expenditure submitted to the Chief of Engineers was duly approved.

In accordance therewith proposals were invited for dredging 600,000 cubic yards of material, more or less. The proposals were opened July 29. The lowest bidder was Mr. Thomas P. Morgan, jr., at 14 cents, with whom a contract was entered into for the work, to be completed June 30, 1882.

Mr. Morgan commenced operations October 15, 1881, with a small clam-shell dredge in the south branch of the Elizabeth River; the plant was very inadequate to the work, but the contractor promised increased machinery and scows; during November, however, this machine only worked four days, and it was not until December 9 that an additional clam-shell of larger capacity, the *Morgan*, and also a dipper dredge were added to the plant. The *Morgan* was employed in the eastern branch of the Elizabeth River above the county bridge, while the dipper dredge was employed in the south branch.

During December, 1881, and January, 1882, work was continued, with only slight interruption, with these three dredges. On February 2, a powerful clam-shell dredge, which the contractor had hired from the Morris & Cummings Company, was put at work in the eastern branch, and continued there to include the 25th of the month, when it was discharged. Another dredge of smaller capacity, hired from G. C. Fobes & Co., was put at work on this day. During this month the small clam-shell worked from 1st to 20th, when she was withdrawn, the *Morgan* from 24th to 28th, and the dipper throughout the month. In March the dipper worked only four days; the *Morgan*, and Fobes dredge were employed the entire month. In April the *Morgan* and Fobes dredge worked in eastern branch from 1st to 7th and 1st to 8th, respectively, when it was supposed that work was finished, and arrangements made for transferring both dredges to the Sewall's Point Bar. The Fobes dredge was put at work on the bar on the 10th and the Morgan on the 13th, and both continued at work until the end of the month. The dipper worked from the 13th to 29th in the south branch.

An examination of the work done in the eastern branch above the county bridge showed that some redredging was necessary to give the required depth over the entire bottom surface, and the contractor was notified to that effect. Up to the close of the fiscal year no action had been taken.

The Fobes dredge worked from May 1 to 4 inclusive, when she was withdrawn by her owners; during the same month the *Morgan* worked from 1st to 23d, when she was withdrawn for repairs.

The dipper dredge also worked on the Portsmouth Flats from 1st to 26th, when she was withdrawn from the work, and the small clam-shell from 8th to 31st on Sewall's Point Bar. This dredge worked throughout June in the same locality, and on the 28th the *Morgan*, having finished repairs, recommenced work there.

Under Mr. Morgan's contract there have been removed from the several localities as follows:

	Cubic yards.
From eastern branch of Elizabeth River	139,029
From south branch of Elizabeth River	20,788
From Sewall's Point Bar	58,649
	218,466

which has been deposited on the flats below Craney Island.

The work in the south branch has been the dredging of lump the United States navy-yard and the partial completion of the w Portsmouth Flats. It is hoped to complete this under the presen tract if it be continued in force. In the eastern branch the wor the dredging of an area of 1,350 by 375 feet lying above the old o bridge, which has been bought and removed by the Norfolk and ern Railroad Company, thus bringing into use a large area formerl less for large vessels. In addition to this, a little dredging at some was done lower down the harbor. At Sewall's Point the secon which is about 14,000 feet long, has been completed and a third and one commenced. This channel now has a width of 70 feet for its length; the other cuts commenced are about 20 feet wide each. contract with Mr. Morgan provided for the removal of soft material In the prosecution of the work in the south branch of the Eliz River some hard material was encountered. The contractor wa delayed by logs underlying the bottom and by having to shift his d frequently to accommodate vessels approaching adjacent wharves. applied for and was granted additional compensation under a mod tion of the contract dated February 28, 1882, approved by the Secr of War, under which he received 20 cents per yard additional for cubic yards, 13 cents per yard additional for 10,922 cubic yards, a per hour for 21½ hours' extra time required for removing logs.

In the eastern branch of the Elizabeth River hard material w countered underlying the soft to the extent of 6,531 cubic yard which Mr. Morgan has been paid 11.4 cents in addition to the con price, under a modification of contract, dated May 3, 1882, approv the Secretary of War.

It will be observed that only a little over one-third of the amou be removed under the contract has been taken out. As it was u impossible for the contractor to complete the work within the spe time, he asked for an extension of six months. This application w ferred to the Chief of Engineers, who granted an extension for one m pending which the subject should receive more full consideration.

Since the original estimate was made for this improvement th crease in commerce has necessitated a large addition to the wharv the harbor. To utilize this property has already required, in the Ea Branch, a large amount of dredging, and still more is needed. The d of dredging has in some instances also been increased. This wi quire appropriations beyond those originally asked for the thorougl provement of the harbor and its approaches.

This work has been under the immediate supervision of Mr. Ge Elliott, Assistant Engineer, to whom my thanks are due for the effi manner in which he has conducted it, as well as the other works w he has superintended.

The statistics of the port of Norfolk and Portsmouth, furnished b collector of customs, as also the cotton statistics by the Norfolk C Exchange, are hereto appended.

The appropriations for this work have been:

August 14, 1876	$3
June 18, 1878	5
March 3, 1879	7
June 14, 1880	5
March 3, 1881	7
August 2, 1882	7
	36

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30 1882

eers, U.S.A.

Money statement.

July 1, 1881, amount available	$100,281 41	
Amount received from sale of coal to Capt. James Mercur	22 50	
		$100,303 91
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	45,835 99	
July 1, 1882, outstanding liabilities	5,451 94	
		51,287 93
July 1, 1882, amount available		49,015 98
Amount appropriated by act passed August 2, 1882		75,000 00
Amount available for fiscal year ending June 30, 1883		124,015 98
Amount (estimated) required for completion of existing project		18,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		18,000 00

Abstract of proposals received for dredging at Norfolk Harbor, Virginia, and opened immediately after 12 *m., July* 29, 1881.

Number.	Name and address.	Time.		Daily amount of work expected.	Price per cubic yard.
		Commence.	Complete.		
				Cubic yards.	
1	F. B. Colton, General Manager National Dredging Company, Washington, D. C.	Oct. 1, 1881	June 30, 1882		$0 16
2	George C. Fobes & Co., Baltimore, Md.	Nov. 20, 1881	July 1, 1882		*0 17
3	Thos. P. Morgan, jr., Cumberland, Md.	At once	June 30, 1882	2,500	0 14
4	Morris & Cumings Dredging Company, New York.				0 18

*In accordance with specifications.

STATEMENT OF PRINCIPAL ARTICLES SHIPPED FROM THIS PORT TO FOREIGN PORTS DURING THE FISCAL YEAR ENDING JUNE 30, 1882.

Cotton	bales	331,971
Staves	number	4,376,607
Coal	tons	2,168
Manganese	do	1,663
Bark	do	320
Shingles	M	100,000
Wheat	bushels	8,980
Lumber	value	$16,510
Bacon	pounds	1,150
Rosin	barrels	200
Flour	do	15,800

		Tonnage.
Number vessels entered from foreign ports	29	54,241
Number vessels cleared for foreign ports	171	135,241
	200	189,482

Amount of collections	$47,376
Value of exports	17,732,038

G. E. BOWDEN,
Collector.

NORFOLK, VA., *July* 15, 1882.

LETTER FROM SECRETARY OF NORFOLK AND PORTSMOUTH COTTON EXCHANGE.

NORFOLK AND PORTSMOUTH COTTON EXCHANGE,
Norfolk, Va., July 20, 1882.

DEAR SIR: Inclosed please find statement of receipts and shipments of cotton for twelve months ending 30th June, 1882, as requested.

	Bales.
Receipts of cotton at Norfolk, twelve months ending 30th June, 1882	625,786
Exported to Great Britain same time	315,685
Exported to France	2,580
Exported to Continent	17,358
Direct exports	335,623
Shipped to coastwise ports, New York, Boston, Providence, Baltimore, and Philadelphia	295,498
Total shipments	631,121

The excess of shipments over receipts is accounted for by *excess* of stock on hand last year as compared with this (viz: 5,335 bales).

Yours, very truly,

NORMAN BELL,
Superintendent and Secretary.

MR. GEORGE H. ELLIOTT,
Assistant Engineer.

PORT OF NORFOLK.—STATISTICS OF COTTON.

[Furnished by the Norfolk and Portsmouth Exchange.]

Comparative statement receipts for five years.

Season.	Through.	Local.	Total.
1881-'82	240,671	382,212	622,883
1880-'81	334,849	384,667	719,516
1879-'80	314,743	283,343	597,086
1878-'79	222,260	221,025	443,285
1877-'78	190,077	229,130	429,267

Comparative statement of foreign exports and coastwise shipments for five years.

Season.	Foreign.	Coastwise.	Total.
1881-'82	331,817	289,032	620,849
1880-'81	328,818	391,843	720,661
1879-'80	257,065	337,226	594,291
1878-'79	203,536	239,158	442,694
1877-'78	159,357	271,055	430,412

The value of our direct foreign exports this season amounts to $17,573,460, which is an excess of $286,413 over the hitherto unprecedented business of our previous season (1880-'81), and an excess of $8,394,445 over season of 1878-'79, three years ago.

I 2.

IMPROVEMENT OF ARCHER'S HOPE RIVER, VIRGINIA.

The act of Congress approved March 3, 1881, appropriated $5,000 for the improvement of this river

A project for expending this sum was submitted to the Chief of Engineers April 2, 1881, and by him approved. The improvement proposed contemplates the dredging of a channel 50 feet wide and 6 feet deep, where these dimensions are not found between the mouth of the river where it empties into the James River, and the city of Williamsburg, for 5 miles above.

Bids for the performance of this work under the modified project were opened January 27, immediately after noon. The only bidders were the New York Stream Dredging Company, at 37½ cents per cubic yard, work to commence February 10. The contract was awarded to this company by authority of the Chief of Engineers.

Work under this contract was commenced February 11, with one dipper dredge; and on the 17th, an additional dredge was put on. These dredges continued work till the 11th of March, when, the appropriation being exhausted, they were withdrawn.

Three small cuts 20 feet wide and 1,400 feet long were completed and a fourth cut two-thirds of this length was made. Twelve thousand two hundred and eighty-three cubic yards of material was excavated and deposited on the other side of the James River.

A final examination was made of the work on the 24th of March, and it was found to be done in accordance with the specification.

No material benefit to navigation has resulted from the work already done, as the appropriation was not sufficient to open the mouth of the river. The original estimate for this river was $13,571.58, but owing to the increased price of dredging this amount will not be sufficient to make the complete improvement; for this purpose there will be required from $15,000 to $20,000, depending upon the amount of diking required.

The work has been under the immediate supervision of Mr. George H. Elliott, assistant engineer.

This work is in the collection district of Yorktown, Va.

Money statement.

July 1, 1881, amount available	$5,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	4,892 03
July 1, 1882, amount available	107 97
Amount appropriated by act passed August 2, 1882	5,000 00
Amount available for fiscal year ending June 30, 1883	5,107 97
Amount (estimated) required for completion of existing project	9,400 70
Amount that can be profitably expended in fiscal year ending June 30, 1884.	9,400 70

Abstract of proposals received for dredging at Archer's Hope River, Virginia, and opened January 27, 1882, immediately after 12 m.

Number.	Name.	Address.	Time.		Price per cubic yard.	Remarks.
			Commence—	Complete—		
1	G. H. Ferris, general manager.	Norfolk, Va.	February 10, 1882	June 30, 1882	$0 37½	Use one dipper dredge.

I 3.

IMPROVEMENT OF PAGAN CREEK, VIRGINIA.

The act of Congress approved June 14, 1880, appropriated $5,000 for this work.

A project for the expenditure of this sum, contemplating the dredging of a channel not less than 60 feet wide and 8 feet deep at mean low-water through three bars nearest Smithfield, was submitted August 26, 1880.

This project was approved, and proposals for dredging 18,000 cubic yards of material, more or less, were invited. The bids were opened October 22, and Mr. H. E. Culpepper, being the lowest bidder, the contract was awarded him at 16½ cents, to be completed June 30, 1881. Unavoidable delays made it impossible for the contractor to finish his work in the specified time. He therefore applied for and was granted an extension of sixty days under authority of the Chief of Engineers, dated June 21, 1881.

Under the extension granted there has been removed since July 1 to 12th August, inclusive:

	Cubic yards.
From Wright's Bar	3,663
From Bridge Bar	8,304
Total	11,967

On the 12th of August the necessary amount having been excavated (18,629 cubic yards), the dredge was withdrawn.

The act of Congress approved March 3, 1881, appropriated $5,000 for the continuance of this work.

A project for expending this sum was submitted April 7 to the Chief of Engineers, and by him approved.

Proposals were invited for removing 18,000 yards, more or less, and the proposals opened July 29. Messrs. Jas. Caler & Co. being the lowest bidders, the contract was awarded them at 23 cents per cubic yard, work to commence November 1, 1881, and to be finished before June 30, 1882. Work under contract with Messrs. Jas. Caler & Co. commenced December 7 on the bar at the mouth of the creek and continued to the 9th of February, 1882.

There was removed under the contract 22,664 cubic yards of material, which was deposited on the west side of James River, outside the creek.

This work has been under the immediate supervision of Mr. Geo. H. Elliott, assistant Engineer.

Pagan Creek is in the collection district of Norfolk, Va.

The appropriations for this work have been:

June 14, 1880	$5,000
March 3, 1881	5,000

Money statement.

July 1, 1881, amount available	$8,707 16
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	8,529 63
July 1, 1882, amount available	177 53
Amount (estimated) required for completion of existing project	18,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	18,000 00

Abstract of proposals received for dredging at Pagan Creek, Virginia, opened immediately after 12 m., July 29, 1881.

Number.	Name and address.	Time.		Number and kinds of machines.	Price per cubic yard.	Remarks.
		Commence—	Complete—			
1	Thos. P. Morgan, jr., Cumberland, Md.	In accordance with specifications.	....	One dipper dredge.	$0 25	500 yds. daily.
2	Jas. Caler & Co., Richmond, Va.	Nov. 1, 1881	June 30, 1882	One dredge ...	23	

I 4.

IMPROVEMENT OF BLACKWATER RIVER, VIRGINIA.

The act of Congress of March 3, 1881, appropriated $1,500 for continuing the work on this river, which consists solely in the cutting off of obstructing points, all work of other character having been done.

A project for the expenditure of the appropriation of $1,500 was submitted April 7, 1881, to the Chief of Engineers and by him approved. Owing to the difficulty, almost impossibility, of procuring the necessary machinery for this work, except at such a cost as would make it inadvisable to attempt operations with such a small appropriation, no work has been done during the year. Arrangements had, however, been made for the outfit needed just before the close of the fiscal year.

Statistics of the commerce of the river will be forwarded when received.

The Blackwater River is in the collection district of Norfolk, Va.

The appropriations for this work have been—

June 18, 1878	$5,000
March 3, 1879	2,500
June 14, 1880	3,500
March 3, 1881	1,500
August 2, 1882	1,500

Money statement.

July 1, 1881, amount available	$1,490 36
July 1, 1882, amount available	1,490 36
Amount appropriated by act passed August 2, 1882	1,500 00
Amount available for fiscal year ending June 30, 1883	2,990 36
Amount (estimated) required for completion of existing project	850 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	1,000 00

I 5.

IMPROVEMENT OF NOTTOWAY RIVER, VIRGINIA.

The act of Congress approved June 14, 1880, appropriated $5,000 for this work, and act approved March 3, 1881, appropriated $2,000.

Owing to insufficient information the appropriation of June 14, was not expended during the fiscal year 1880–1881, and a project for the expenditure of both appropriations was submitted May 28, 1881.

The improvement proposed consists in the removal of all obstructions, natural and artificial, that now impede navigation as high as "Peters' Bridge," a distance of about 50 miles above the mouth of the river. This project was approved by the Chief of Engineers.

The work was commenced August 17, 1881, with labor and machinery procured in open market. The initial point of this work was at the mouth of the river, and consisted in removing wrecks. For this the services of a diver were required for six days, and a depth of 11 feet was secured.

Work was pushed forward till the early part of February, when the river was too high for advantageous work. The plant was therefore withdrawn. The work consisted in removing from the channel 1,917 sunken logs, 477 sunken trees, and 547 stumps. The banks were cleared of overhanging trees, likely to obstruct navigation, for a distance of 33½ miles, and 1,586 trees were cut down and removed.

This work has been under the immediate supervision of Mr. George H. Elliott, assistant engineer.

The Nottoway River is in the collection district of Norfolk, Va.

The appropriations for this work have been—

June 14, 1880	$5,000
March 3, 1881	2,000
	7,000

Money statement.

July 1, 1881, amount available	$7,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	6,420 30
July 1, 1882, amount available	579 70
Amount (estimated) required for completion of existing project	2,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	2,000 00

I 6.

IMPROVEMENT OF NORTH LANDING RIVER, VIRGINIA AND NORTH CAROLINA.

The act of Congress approved March 3, 1881, appropriated $7,50 for continuing this work.

A project for the expenditure of this sum was submitted April 2, whic contemplated the continuance of the work in cutting off obstructin points. This project was approved by the Chief of Engineers. Th object has been to secure a channel 80 feet wide, 9 feet deep at lo water, and to clear the channel of logs, snags, and trees.

Machinery and labor for the accomplishment of this work has bee secured in open market.

A dredge was employed in digging between Cypress Point and Doub S Bend till the 14th of September, and excavated 9,410 cubic yar of material. From the 14th of September till the close of same mont the dredge was employed on Stumpy Tree Reach, and removed 3,9 yards of material. Work was suspended early in October, owing malarial sickness and necessary repairs to machinery.

Work was resumed February 10, and consisted in clearing the cha nel of sunken logs, stumps and trees. There were taken out from the channel and deposited on the banks 552 logs, 164 stumps, and 7 trees.

This river is a connecting link in a line of interior water communication south from Norfolk, Va., via the Albemarle and Chesapeake Canal.

The work has been under the immediate supervision of Mr. George H. Elliott, assistant engineer.

The work is in the collection district of Norfolk, Va.

Statistics for this work, which also relate to Currituck Sound are appended, having been furnished by the president of the Albemarle and Chesapeake Canal Company, Hon. Marshal Parks.

The appropriations for this work have been:

March 3, 1879	$25,000
June 14, 1880	15,000
March 3, 1881	7,500
August 2, 1882	8,000
	55,500

Money statement.

July 1, 1881, amount available	$7,250 68
July 1, 1882, amount expended during fiscal years, exclusive of outstanding liabilities July 1, 1881	5,999 76
July 1, 1882, amount available	1,250 92
Amount appropriated by act passed August 2, 1882	8,000 00
Amount available for fiscal year ending June 30, 1883	9,250 92
Amount (estimated) required for completion of existing project	32,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	25,000 00

Report of number and class of vessels employed navigating the southern branch of the Elizabeth River, North Landing River, in Virginia, Currituck Sound, and North River in North Carolina, via Albemarle and Chesapeake Canal, from 1st July, 1881, to 1st July, 1882.

Date.	Steamers.	Schooners.	Sloops.	Barges.	Lighters.	Boats.	Rafts.	Total.
1881.								
July	202	257	96	41	17	89	25	727
August	251	95	59	40	33	44	27	549
September	262	85	19	42	23	14	27	472
October	281	81	14	48	24	3	22	473
November	265	79	14	39	33	5	24	459
December	301	135	28	99	18	2	16	599
1882.								
January	273	119	42	72	17	6	17	546
February	264	139	43	70	20	11	17	564
March	325	149	32	83	15	6	28	638
April	327	141	35	78	12	2	25	620
May	323	142	43	69	7	9	27	620
June	273	100	27	58	24	......	27	509
	3,347	1,522	452	739	243	191	282	6,776
North	1,699	758	227	369	120	96	282	3,551
South	1,648	764	225	370	123	95	......	3,225
Total	3,347	1,522	452	739	243	191	282	6,776

Statement of inward receipts of leading items of produce, transported from points on the Pamplico, Croatan, Albemarle, Cove, and Currituck sounds, of North Carolina, embracing all of the leading rivers, via the Albemarle and Chesapeake Canal, from 1st July, 1881, to 1st July, 1882.

Date.	Cotton.	Fish.	Naval stores.	Spirits of turpentine.	Rags.	Old iron and junk.	Eggs.	Bacon.
1881.	*Bales.*	*Barrels.*	*Barrels.*	*Casks.*	*Pounds.*	*Pounds.*	*Dozens.*	*Pounds.*
July	319	210	1,334	22	12,480	19,070	5,350	6,910
August	196	37	2,377	125	8,080	7,428	2,480	5,220
September	3,217	21	1,585	16	11,050	6,240	3,695	5,900
October	13,392	195	300	....	8,770	67,500	4,244	3,700
November	19,097	327	498	6	8,280	13,760	5,660	6,910
December	23,312	192	1,017	7	13,810	8,75[illegible]	14,060	14,970
1882.								
January	9,271	171	318	18	5,850	1,960	7,780	19,890
February	7,494	268	1,230	165	13,075	19,060	17,290	32,860
March	4,230	578	1,266	58	10,360	20,900	21,760	4,000
April	1,083	1,271	675	....	14,520	11,990	14,580	14,440
May	505	3,302	686	7	12,810	15,400	17,000	13,020
June	101	24	554	25	9,660	3,700	13,881	13,807
Total	82,217	6,596	11,840	449	128,745	195,758	128,780	141,627

Date.	Pine and oak wood.	Corn.	Peas and beans.	Railroad ties.	Potatoes.	Juniper logs.	Peanuts.	Rough rice.
1881.	*Cords.*	*Bushels.*	*Bushels.*		*Bushels.*	*Cords.*	*Bushels.*	*Bushels.*
July	49	14,568	12	10,047	4,895	205	370	....
August	102	20,960	14	9,475	970	376	....	....
September	60	14,231	....	14,707	5,058	352	....	....
October	241	3,304	583	18,597	4,937	240	....	225
November	99	4,372	553	9,938	3,562	178	132	5,196
December	114	32,073	148	13,592	2,868	208	....	2,353
1882.								
January	48	61,137	449	12,069	511	241	572	5,220
February	71	68,265	645	9,380	3,667	473	440	3,115
March	31	46,950	1,961	12,965	3,616	456	179	1,645
April	....	76,859	749	12,222	3,274	271	....	2,700
May	3	20,494	848	20,492	4,011	667	....	4,500
June	326	17,065	423	9,089	14,871	259	....	1,200
Total	1,144	380,278	6,385	152,573	52,240	3,986	1,693	26,154

Date.	Wheat.	Lumber, B.M.	Shingles.	Staves.	Articles un-enumerated,	Passengers.
1881.	*Bushels.*	*Feet.*			*Tons.*	
July	1,627	7,133,278	2,311,400	8,500	8,750	150
August	2,968	5,839,379	3,267,445	3,775	9,810	208
September	137	5,065,581	3,581,400	3,000	10,940	162
October	225	5,144,791	2,044,250	359	18,740	141
November	30	4,760,781	1,276,450	8,400	12,190	157
December	....	4,342,412	2,422,400	5,500	11,870	202
1882.						
January	....	4,366,865	2,431,150	20,500	8,710	194
February	....	5,832,231	1,672,900	6,800	14,970	159
March	....	6,324,502	1,968,025	29,500	20,710	141
April	....	7,140,099	2,845,125	4,500	9,114	143
May	43	7,787,656	3,740,000	1,123	7,119	210
June	....	7,018,161	2,377,650	1,185	14,192	214
Total	5,050	70,785,736	29,938,195	93,307	147,115	2,081

I 7.

IMPROVEMENT OF CURRITUCK SOUND, COANJOK BAY, NORTH RIVER AND BAR, NORTH CAROLINA.

This work, which is a connecting link in a contemplated line of inland navigation to the south, via the Albemarle and Chesapeake Canal, was originally commenced under an appropriation of $20,000 made by act of

Congress approved June 18, 1878, for the improvement of Currituck Sound and North River Bar, North Carolina.

The plan of improvement adopted was the dredging of a channel 80 feet wide at bottom and 9 feet deep at an ordinary winter stage of water through the entire length of the upper part of Currituck Sound, about 10½ miles.

A general description of the work accomplished under the appropriations prior to that of March 3, 1881, has been given in previous reports, with the exception of what was done by the National Dredging Company, the contractors for dredging under the appropriation of June 14, 1880, who were to have completed their contract by June 30, 1881. Finding themselves unable to do so, they asked for and were granted an extension of sixty days by authority of the Chief of Engineers, under which they removed from between beacons 7 and 8 in Currituck Sound, the location of which is given on sketches previously forwarded, 25,343 cubic yards of material, making a total quantity removed under this contract of 137,501 cubic yards. This material, as well as all subsequently dredged, was deposited on the east and west sides of the sound.

The river and harbor act of March 3, 1881, appropriated $30,000 for Currituck Sound, Coanjok Bay, North River and Bar, North Carolina. This brings North River, not previously included, within the scope of the appropriation, and as no estimate for the improvement of this river has been submitted in connection with this work, when opportunity offers an examination will be made and an estimate of cost of improvement submitted.

A project for the expenditure of this appropriation was submitted to the Chief of Engineers April 2, 1881.

The project was approved, and in accordance therewith proposals were invited for removing 90,000 cubic yards of material, more or less. The lowest bidders were James Caler & Co., at 17½ cents, whose bid was accepted.

Proposals were also invited for the delivery in place of 312,000 bushels of oyster shells, more or less, for a bank across Coanjok Bay. Only two bids were received, one at 7½ cents per bushel, and one unaccompanied by bond, at 7 cents per bushel, which being considered too high, both were rejected.

Such shells as were required were afterwards purchased in open market at 6 cents per bushel, delivered.

Work under the contract with Messrs. James Caler & Co. was commenced early in October, with one dredge, in the cut at the north end of Coanjok Bay; on the 24th of February a second dredge was put at work on the same cut, and there continued until the 4th of March; on the 9th of March the second dredge was moved between beacons 6 and 7, and remained at work there till the 16th of June. The first dredge continued work in the cut at north end of Coanjok Bay till the 5th of June, and was then withdrawn.

The second dredge was removed from between beacons 6 and 7 on the 16th of June and worked in the cut at north end of Coanjok Bay till the 20th of June, when work under this contract ceased.

There was removed under this contract—

	Cubic yards.
From cut in Currituck Sound	33,127
From cut at north end Coanjok Bay	34,613
	67,740

The work accomplished during the fiscal year has been the completion of the channels between beacons 6 and 7 and 7 and 8 to their full dimensions of not less than 80 feet wide at bottom and 9 feet deep, and the cutting back the bank at north end of Coanjok Bay about 35 feet for its entire length of about 2,000 feet, making the cut at this place 100 feet wide on the water surface and about 80 feet at bottom. The entire cut has not, however, been dredged to its full depth.

Piles for building a bulkhead for the protection of the bank at Coanjok Bay have been driven, 230,966 bushels of oyster shells have been delivered, and a bank extending across Coanjok Bay has been constructed, protecting the cut for its entire length of 9,200 feet. The work has been under the immediate supervision of Mr. George H. Elliott, assistant engineer.

This work is in the collection district of Norfolk, Va.

The appropriations for the work have been—

June 18, 1878	$20,000
March 3, 1879	25,000
June 14, 1880	25,000
March 3, 1881	30,000
August 2, 1882	20,000
	120,000

Money statement.

July 1, 1881, amount available		$35,300 81
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$34,073 15	
July 1, 1882, outstanding liabilities	100 25	
		34,173 40
July 1, 1882, amount available		1,127 41
Amount appropriated by act passed August 2, 1882		20,000 00
Amount available for fiscal year ending June 30, 1883		21,127 41
Amount (estimated) required for completion of existing project		20,213 95
Amount that can be profitably expended in fiscal year ending June 30, 1884		20,200 00

Abstract of proposals received for dredging at Currituck Sound and Coanjok Bay, North Carolina, and opened immediately after 12 m., July 29, 1881.

Number.	Name and address.	Time.		Number and kinds of machines.	Price per cubic yard.	Remarks.
		Commence—	Complete—			
1	G. H. Ferris, Norfolk, Va.	Nov. 15, 1881.	July 1, 1882.	....	$0 65 23	At Long Point. At Feriby's Island.
2	Jas. Caler & Co., Richmond, Va.	Sept. 1, 1881.	June 30, 1882	1 dredge	17½	

Abstract of proposals received for delivery of oyster shells at Coanjok Bay, North Carolina, and opened immediately after 12 m., July 29, 1881.

Number.	Name and address.	Time.		Price per bushel.	Remarks.
		Commence—	Complete—		
1	Edward Pickup, Norfolk, Va.	Oct. 1, 1881.	Mar. 1, 1882	$0 07½	In accordance with specification.
2	Geo. V. Scott & Son, Petersburg, Va.	....	....	07	No bond given.

I 8.

IMPROVEMENT OF SCUPPERNONG RIVER, NORTH CAROLINA.

Work during the fiscal year has been carried on under a balance of appropriation of June 14, 1880, and the appropriation ($1,000) March 3, 1881.

A project for the expenditure of the last appropriation was submitted April 7, 1881, which proposed the continuance of operations in accordance with the original plan, which, since dredging through the bar at the mouth, and the removal of logs and stumps, and the trimming of banks, consisted simply of making cuts-off at obstructing points, and some through cuts. The project was approved by the Chief of Engineers.

The great demand for dredging appliances prevented any operations until June 11, at which date work was commenced at a cut-off at a place known as "Rattlesnake Bend," which was left incomplete last year. This was finished, and the dredge moved to another cut-off, known as "Old Turnround," at which a cut was made through one of the points. The other point at this locality was cleared ready for the dredge, but, the appropriation being nearly exhausted, dredging was not commenced, the machinery being used in trimming off until the close of the fiscal year two obstructing points in the vicinity.

The work has been done by hired labor and machinery, and the purchase of material in open market.

The work has been under the immediate supervision of Mr. Geo. H. Elliott, assistant engineer.

Scuppernong is in the collection district of Albemarle, North Carolina.

Such statistics as can be obtained will be forwarded.

The appropriations for the work have been:

June 18, 1878	$2,000
March 3, 1879	2,000
June 14, 1880	1,000
March 3, 1881	1,000
	6,000

Money statement.

July 1, 1881, amount available		$1,258 45
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$214 15	
July 1, 1882, outstanding liabilities	1,033 66	
		1,247 81
July 1, 1882, amount available		10 64
Amount (estimated) required for completion of existing project		2,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		2,000 00

I 9.

IMPROVEMENT OF PAMPLICO AND TAR RIVERS, NORTH CAROLINA.

The river and harbor act of March 3, 1881, appropriated $8,000 for continuing the improvement of these rivers. Work under this appropriation has been carried on in accordance with the approved project which contemplated spending equal amounts upon each river.

The execution of this work has been superintended to my complete satisfaction by Mr. John P. Darling, assistant engineer, except between November 11 and April 28, during which time dredging operations were carried on under the superintendence of Mr. Reid Whitford, overseer. In this time there was removed 4,088 cubic yards of roots and mud; 939 stumps, of which 133 required blasting, 465 pounds of powder and 70 pounds of dynamite being used for this purpose, making a total removed from the Pamplico for this year of 6,503 cubic yards of mud and roots, and 1,215 stumps, of which 170 required blasting.

This dredging has secured the completion of a channel through the old shoal in the Pamplico below Washington of a depth of 9 feet, and a least width of 108 feet, the objectionable bend formerly in the channel having been removed.

In the Tar 12 jetties, with a total length of 1,436 linear feet, have been built; 80 logs, 24 stumps, and 175 snags have been removed.

Owing to the extreme low-water of last fall not allowing the pile-driver or hoister to float, work was suspended on September 29, and recommenced November 8, upon the first rise of the river.

The work included in the original estimate for this river having been completed, a survey has been made to determine its effect, and to determine what further work is needed. The results of this survey will be plotted and forwarded as soon as completed.

A copy of Mr. Darling's report is appended, to which I would respectfully refer for further details of work done, and commercial statistics of Washington, North Carolina, which is the shipping port for both rivers.

The appropriations for the work have been:

June 14, 1880	$9,000
March 3, 1881	8,000
August 2, 1882	10,000
	27,000

Money statement.

July 1, 1881, amount available		$8,863 37
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$6,425 34	
July 1, 1882, outstanding liabilities	368 75	
		6,794 09
July 1, 1882, amount available		2,069 28
Amount appropriated by act passed August 2, 1882		10,000 00
Amount available for fiscal year ending June 30, 1883		12,069 28
Amount that can be profitably expended in fiscal year ending June 30, 1884.		12,000 00

REPORT OF MR. JOHN P. DARLING, ASSISTANT ENGINEER.

Washington, N. C., July 1, 1882.

CAPTAIN: I have the honor to submit the following report on the improvement of Pamplico and Tar Rivers, North Carolina, for the year ending June 30, 1882:

The river and harbor bill of March 3, 1881, appropriated $8,000 for continuing the improvement of Pamplico and Tar Rivers. The project for the expenditure of this sum contemplated dividing the amount equally between the two rivers, and continuing the work of widening and straightening the dredged channel 1¼ miles below Washington by dredging, and the removal of stumps, roots, &c.

In the Tar, by the construction of additional jetties and removing logs, stumps, and snags brought down by the freshets; also in repairing some of the old jetties. Dredging and removing stumps, roots, &c., from the Pamplico was continued through July and seven days in August, when operations were stopped to allow the plant to go up the Tar and do the work there during low-water, which is the most favorable time.

There was removed from Pamplico during July and August 2,415 cubic yards of mud, roots, and sand; also 276 stumps; some of them were very large cypress and gum, 37 of which were blasted.

Work was commenced on the Tar River the 10th of August and continued until the 29th of September. During this time three jetties were built near Red Bank, about 2 miles below Greenville, and one at the latter place; these four jetties contained 686 lineal feet; 34 logs, 12 stumps, and 81 snags were removed from the river below Greenville. Above that place eight jetties were constructed containing 750 linear feet.

There were removed from the river between Greenville and Center Bluff 46 logs, 12 stumps, and 94 snags. The jetties were built of two rows of piles; the rows 3 feet apart; the piles 5 feet apart. The space between the rows is solidly packed with brush, and heavy cross-pieces spiked on near the top; the lines of piles are wattled with brush.

On the 29th of September the water was lower than it had been for years, and we were compelled to stop work, as the hoister and pile-driver were aground, and we were unable to move them until the 8th of November, when we came down the river, and recommenced work November 12 on the Pamplico, straightening the channel between points A and C (see map accompanying annual report June 30, 1880), which work I think was completed in March, 1882. I do not know the amount of material removed during that time, as in accordance with your orders I left here on the 18th of November to make some surveys, and did not return until the 28th of April. There was nothing done during May on account of high-water in the Tar, except preparing the pile-driver and getting out 200 piles ready to put in bank-protectors at the cut-off about 2¼ miles above Greenville where the banks were washing badly.

In compliance with your orders I proceeded to Tarborough on the 7th of June to make a survey of the Tar River, which was commenced on the 13th of June, and on the 30th was completed as far as Greenville, a distance of a little over 27 miles from Tarborough. When the survey is finished a detailed map showing the improvement of the river, and a report and estimate for further improvement, will be made.

At present there are but two steamers running on the Tar River, one having been taken off for repairs, but will go back on the line as soon as refitted. The new steamer built for this river by the Old Dominion Steamship Company last year was taken off after a few trips.

The boats commenced running to Tarborough the 1st of November, 1881, and continued to do so with the exception of a few trips until June 12, 1882, when the water was too low for them to get to that place, and they have made but one trip since. The principal shipments coastwise and foreign from Washington for the year ending June 30, 1882, were as follows:

Cotton	bales	35,699
Rice	bags	8,666
Lumber	feet	5,000,000
Naval stores	barrels	10,469
Pease	bags	115
Wax	barrels	42
Shingles		1,030,000
Staves		42,900
Barrels, boxes, and crates, miscellaneous		3,582
Bales		120

The following table shows the increase of principal articles shipped from Washington for the last three years:

Articles.		1880.	1881.	1882.
Cotton	bales	21,000	27,875	35,699
Rice	bags	....	4,960	8,666
Lumber	feet	1,281,000	3,490,975	5,000,000

It will be seen from this table that the shipments of the three principal products are increasing very fast. Although there is no record kept of the imports, they are said to have increased 33 per cent. in the last year.

I am, captain, very respectfully, your obedient servant,

JNO. P. DARLING,
Assistant Engineer.

Capt. JAMES MERCUR,
Corps of Engineers, U. S. A.

I 10.

IMPROVEMENT OF NEUSE RIVER, NORTH CAROLINA.

The river and harbor act of March 3, 1881, appropriated $30,000 for this work.

Operations have been conducted during the year in accordance with the project submitted April 8, 1881.

The supervision of this and several other works has been intrusted to Mr. R. Ransom, assistant engineer, to whom my thanks are due for the ability and zeal with which he has conducted them. A copy of his report is appended.

The working party in the upper river between Goldsborough and Smithfield have cleared the river of logs, stumps, &c., and the banks of overhanging trees for a distance of more than 20 miles, over most of which the work was very heavy.

In the Lower Neuse, between Kinston and New Berne, a number of bank protectors have been built; those needing it have been repaired, and 14,550 linear feet of plank jetties have been put in, principally between Pitch Kettle and Becton's Old Field.

The channel connecting the Neuse and Trent along the east front of New Berne has been dredged to a width of 100 feet and a depth of 9 feet for a length of 660 feet.

The jetties which were put in during the summer of 1881 stood the long high-water of the winter with very little damage, but a very few needing any repairs when the river fell to its low stage.

These jetties, which have been previously described, have so far answered their purpose remarkably well, and have improved the navigation very much, so that 3 feet can be carried from New Berne to Kinston the entire year, to Goldsborough for six months, and to Smithfield four months; 2 feet from Kinston to Goldsborough eight months and to Smithfield six months. During summer and early fall navigation is uncertain above Kinston except during freshets.

Additional jetties are needed between Kinston and Becton's Old Field, and will be constructed as far as the money available allows.

This river seems to be favorable in slope and bottom for improvement by jetties, and a temporary improvement is already accomplished. Its degree of permanence can only be determined by experience, but doubtless small annual appropriations will be required to repair damages and to build supplemental jetties should they be required.

The improvement of the river has been more extended than the original estimates contemplated, and its completion will cost more than the original amount considered necessary. The navigation has, however, increased so much since the work of improvement has been carried on (three new boats having been completed and two being in process of construction—one only was running originally), and the amount of merchandise carried is so much greater than before, that the whole depth of water gained by the improvement is utilized.

For the exports from New Berne for the year I would respectfully refer to the report of Mr. R. Ransom, assistant engineer, and the statement of the collector forwarded herewith.

The appropriations for the work have been:

June 18, 1878	$40,000
March 3, 1879	45,000
June 14, 1880	45,000
March 3, 1881	30,000
August 2, 1882	35,000
Total	195,000

Money statement.

July 1, 1881, amount available		$54,865 95
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$39,041 78	
July 1, 1882, outstanding liabilities	4,431 61	
		43,473 39
July 1, 1882, amount available		11,392 56
Amount appropriated by act passed August 2, 1882		35,000 00
Amount available for fiscal year ending June 30, 1883		46,392 56
Amount (estimated) required for completion of existing project		13,761 84
Amount that can be profitably expended in fiscal year ending June 30, 1884		15,000 00

REPORT OF MR. R. RANSOM, ASSISTANT ENGINEER.

NEW BERNE, N. C., *June* 30, 1882.

CAPTAIN: I have the honor to submit the following report of operations for the improvement of Neuse River for the past twelve months.

More than 20 miles of progress has been made between Goldsborough and Smithfield in clearing the stream since the date of my last annual report. Most of the work has been heavy, and has been done thoroughly and within most reasonable limits of cost. By the channel of the river it is cleared to within about 23 miles of Smithfield. During the past month 220 large logs, 231 small logs, 11 large stumps, and 25 small stumps have been taken from the channel, and 897 large trees and 909 small ones cut from the banks, besides large quantities of small undergrowth. This month's operations give a fair idea of the work accomplished during the year.

Between Kinston and Pitch Kettle 14,550 feet of heart-pine lumber jetties have been put in, mainly between Pitch Kettle and Becton's Old Field. These jetties have been fully described in former report.

The channel upon the east front of this place, connecting Neuse and Trent rivers, and greatly facilitating all navigation, saving to steamers a mile or more each way from one part of the city to the other, during last fall was dredged to 100 feet wide, 660 feet long, and 9 feet deep at low-water.

From the 1st of January to the 20th of March the machinery and force upon this part of the river were transferred to Moccasin River or Contentnea Creek, as the water was too high for jettying. From the 20th of March till the latter days of May the time was utilized in repairing bank protectors and bank revetments and in putting in others that were found to be required.

I am glad to report that the large amount of jetties put in last summer and fall have stood the test of a heavy winter rise admirably, a very small part being injured.

A gap in the jetties remains to be filled between railroad, near Kinston, and Becton's Old Field. This work is progressing rapidly now, over 2,000 feet having been put in this month; and if means continue to be supplied the jettying will be completed by or before autumn freshets.

Below I give statistical table, showing approximately the trade of this place. This statement is taken from the reports of the board of trade, and the manager of water and railroad transportation lines. The amounts are within the true totals, and a comparison with my report of 1879 will demonstrate the highly thrifty and improving condition of this region. To the improvement of the streams for navigation is very justly attributable the justifying results.

The whole work has been done by hired labor and no other is practicable.

This work lies mainly in the 2d collection district of this State, a small portion above Goldsborough being in the 4th collection district.

COMMERCIAL STATISTICS SUPPLIED BY THE BOARD OF TRADE OF NEW BERNE, NORTH CAROLINA, FOR THE YEAR ENDING MAY 31, 1882.

Articles.		Year ending May 31, 1882.	Year 1881.
Rice	bushels	150,000	67,440
Rice	tierces	1,400	200
Corn	bushels	800,000	436,368
Cotton	bales	44,300	34,500
Wooden plates		10,000,000	8,000,000
Lumber	feet	11,500,000	9,150,000
Shingles		8,000,000	9,000,000
Naval stores	barrels	10,000	6,098
Cotton-seed meal	tons	200	....
Cotton-seed oil	barrels	200	....
Watermelons		40,000	Not known.
Salt fish	barrels	3,700	3,000
Fresh fish	pounds	2,650,000	1,152,000
Oysters, canned	cases	6,000	None.
Clams	pounds	1,000	Do.
Rags	bales	500	Do.
Hides	do	400	Do.
Whale oil	barrels	100	Do.

The production of vegetables this year is very largely over that of any proceding season, the trucking interest having outgrown proportionately any other industry.

Very respectfully, your obedient servant,

R. RANSOM,
Assistant Engineer.

Capt. JAMES MERCUR,
United States Engineers.

LETTER OF COLLECTOR OF CUSTOMS AT NEW BERNE, NORTH CAROLINA.

CUSTOM HOUSE, NEW BERNE, N. C.,
Collector's Office, July 6, 1882.

SIR: In compliance with your request, I herewith present the commercial statistics of this collection district for the last fiscal year (June 30, 1882).

Vessels entered from foreign ports, 6	tons	8,000
Vessels cleared for foreign ports, 8	do	1,000
Vessels entered, coastwise, 320	do	146,000
Vessels cleared, coastwise		No record.
Total value of domestic exports		$11,078 00
Total value of dutiable imports		8,609 17
Amount of duty collected		2,711 81

Very respectfully,

T. A. HENRY,
Collector.

Gen. ROBERT RANSOM.

I II.

IMPROVEMENT OF TRENT RIVER, NORTH CAROLINA.

The river and harbor act approved March 3, 1881, appropriated $5,000 for this river, which has been expended during the fiscal year in carrying out the approved project submitted April 8, 1881.

The result of the work has been to remove 18,000 yards of material, 2,000 yards of which were shell rock, which required blasting before it was dredged, to make an incomplete turning basin at Trenton, and to trim the banks in the vicinity of Quaker Bridge. This gives a channel allowing boats of 4 feet draught of water to reach Trenton at all times of the year. This channel, below Quaker Bridge, will require the expenditure of $5,000 to make it as good as need be wished. Between Quaker Bridge and Trenton, 13 miles, the river is crooked and narrow, and while admitting navigation by small steamers will not allow the larger ones to reach Trenton. To make this properly navigable will require dredging off the projecting points, widening the narrowest parts, and completing the turning basin at Trenton.

The assistant engineer superintending the work estimates that this can be done for $35,000 or $40,000, or a total for the river of, say, $45,000, to cover contingencies.

The work already done has produced most satisfactory results, and has contributed very largely to the prosperity of the surrounding country. In this connection, I would respectfully invite attention to the statement of Mr. C. E. Foy, president of the New Berne Board of Trade, contained in the appended copy of the report of Mr. R. Ransom, assistant engineer, who has the supervision of this improvement.

This statement shows very clearly the benefit resulting from the work as far as carried.

The estimates made by Mr. Ransom, for the completed improvement, are based upon his thorough knowledge of the stream, and his experience in its improvement, and are therefore to be received as reliable. Any appropriations for further improvements may be based upon them without further survey.

Money statement.

July 1, 1881, amount available	$4,848 57
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	4,848 57
Amount appropriated by act passed August 2, 1882	10,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	25,000 00

REPORT OF MR. RANSOM, ASSISTANT ENGINEER.

NEW BERNE, N. C., *May* 18, 1882.

CAPTAIN: I have the honor to submit the following account of operations upon Trent River improvement since the date of my last Annual Report:

At that time but a small portion of the last appropriation of $5,000 remained. The dredge was kept at work till the 18th of August, and a small force of laborers remained until the first of September. During July and August about 18,000 yards of material were dredged; of that amount 2,000 yards was shell rock, which required blasting. This work completed a channel up to Trenton, the head of practicable navigation, of 4 feet in depth at all seasons, dug an incompleted basin to enable boats to turn at Trenton, and cleared off a small distance upon the banks in the vicinity of Quaker Bridge. The appropriation having been exhausted, operations ceased entirely on the 31st of August.

It may be in place to recapitulate regarding work upon this stream. There have been three appropriations, of $7,000, $10,000, and $5,000, respectively. These sums do not quite cover the primary estimates for the improvement of the river. In my previous reports attention was directed to the inadequacy of the amount estimated for by the surveyors, and reasons given for this opinion. Experience has confirmed this statement. The survey was made most imperfectly by reason of haste, insufficiency of means, and very high water at the time of survey.

Below, I append an extract from report made for your information by the president of the New Berne Board of Trade and president of Trent River Transportation Company, Mr. C. E. Foy:

SHIPMENTS OVER TRENT RIVER SINCE JUNE, 1881, ALLOWING PROPORTIONATE AMOUNTS FOR SEASON UNEXPIRED, TO JUNE 30, 1882; MOST OF THE ARTICLES, EXCEPT VEGETABLES, HAVING BEEN ALREADY SHIPPED:

Articles.		Quantity.	Value.
Cotton	bales	7,800	$390,000
Corn	bushels	100,000	75,000
Rice	do	6,500	6,500
Cotton seed	do	40,000	4,500
Vegetables	packages	6,000	8,500
Irish potatoes	barrels	3,000	9,000
Meal	bushels	4,000	3,500
Naval stores	barrels	2,800	6,000
Wool	pounds	9,000	2,500
Bricks		1,000,000	7,000
Guano	tons	2,500	100,000
Bagging	yards	40,000	4,000
Iron ties	pounds	65,000	3,500
Salt	sacks	3,000	3,000
Flour	barrels	7,000	40,000
Pork	do	2,500	45,000
Molasses	do	800	9,500
Snuff	do	200	1,500
Nails	kegs	750	2,250
			820,250

Many articles have not been enumerated. Before the government improvements were begun not a dollar was invested in steamboats on this river. Now we have quite a number of steamers navigating the Trent, and many thousand dollars invested in the business. Commerce is much checked by larger steamers not being able to reach Trenton. One thousand bales of cotton received by way of Trent River was considered a large amount for one season. You see the increase in less than three years. The sales and shipment of machinery, fertilizer, and agricultural implements are ten times greater than at that time. No man could estimate the increased prosperity of this Trent River section, unless he knew the condition before the beginning of this government improvement.

In the first year the increase has been more than 50 per cent., and the demands for increased facilities justify me in backing the citizens in their appeal for money sufficient to complete the works as they ought to be. Careful consideration has enabled me to form a fair estimate of what should be done, and the cost of the same.

Below Quaker Bridge to New Berne, 30 miles, $5,000 will, properly expended, finish the needed work. From Quaker Bridge to Trenton, about 13 miles, the stream is narrow and crooked. It is navigable for small, short, narrow boats, but those passing with facility over the lower part of the river should traverse the upper portion likewise. To remedy or remove obstructions will require the use of a dredge boat to cut off sharp points, widen narrow places, and to enlarge and deepen the basin at Trenton. An accurate measurement of this necessary work has not been made, but one sufficiently so to determine as definitely as is necessary for practical purposes, enables me to state that $35,000 or $40,000 can be most advantageously applied to this improvement. Unnecessary expense is incurred by small or insufficient appropriations. Could this work have been continued the past fall, at least 20 to 25 per cent. could have been saved in its cost. The transfer of machinery, making new arrangements with owners of proper appliances, loss and injury of material purchased, starting and stopping work, and many other causes, combine to produce the wasteful results.

With thorough information of the condition of the river and of the capabilities and growing prosperity of this region, I confidently state the propriety of an appropriation of $45,000 to finish as it should be done the work needed upon this stream.

Very respectfully, your obedient servant,

R. RANSOM,
Assistant Engineer.

Capt. JAMES MERCUR,
United States Engineer.

I 12.

IMPROVEMENT OF CONTENTNEA CREEK, NORTH CAROLINA.

The river and harbor act approved March 3, 1881, appropriated $10,000 for the improvement of this creek, which sum has been nearly expended in carrying out as far as practicable the project submitted April 8, 1881.

The supervision of this work was given to Mr. R. Ransom, assistant engineer, a copy of whose report is appended hereto.

Work was commenced upon the Lower Narrows near the mouth of the creek with a small force, and a limited amount of cheap training-wall established to define rather than improve the channel.

The principal work upon the creek consisted in clearing out logs, snags, stumps, and trees, and clearing the banks of overhanging trees, and those liable to fall into the stream. This work was done by the use of the plant belonging to the Neuse during the time that the water was too high to work advantageously in the Neuse.

This clearing was carried out for a distance of about 25 miles before the appropriation was exhausted; about 2,000 logs and 800 stumps being removed from the river, and 3,000 large trees removed from the banks in addition to the small growth cut away.

To complete the improvement the same clearing out should be continued up to Stantonsburg, 70 miles above the mouth of this creek, and the best possible channel secured through the lower 3 miles of the creek.

The improvement of this part known as the Lower Narrows so as to secure good water at all times of the year would involve large expense, for, as stated in the report of the assistant engineer, it has no banks, and in very dry seasons has a depth of but 4 to 6 inches of water over a bottom composed of sand. Any rise of the Neuse, occurring as it frequently does when the Contentnea is low, floods across the intervening point, and backs up into the Contentnea, making of its mouth a swampy lake rather than a stream.

To prevent this, very high and long dikes would be required, and after their construction the Neuse would still back up Contentnea through its mouth, causing deposits and bars which would be more or less permanent.

Fortunately, however, the main water transportation by way of this stream is required during the season of flush water, so that a large part of the traffic would be accommodated by clearing out the trees and stumps in the lower narrows, placing training-walls of cheap construction to mark the channel and encourage such slight scour as can be obtained, and dredging off any projecting or hard points so that the light-draught steamers could navigate the stream during the high-water stages. The limited summer traffic could then be accommodated in push boats.

I would respectfully invite your attention to the report of Mr. Ransom, assistant engineer, containing quotations from a letter of the president of the New Berne Board of Trade, showing the relief afforded to the producers living along this creek by the improvements already made, and indicating the advantages which would result from a complete opening of the stream.

Contentnea Creek is in the second collection district of North Carolina.

The appropriations for this work have been:

March 3, 1881	$10,000
August 2, 1882	10,000

Money statement.

July 1, 1881, amount available	$10,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	9,693 99
July 1, 1882, amount available	306 01
Amount appropriated by act passed August 2, 1882	10,000 00
Amount available for fiscal year ending June 30, 1883	10,306 01
Amount (estimated) required for completion of existing project	20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	20,000 00

REPORT OF MR. R. RANSOM, ASSISTANT ENGINEER.

NEW BERNE, N. C., *May* 18, 1882.

CAPTAIN: I have the honor to submit the following report of operations for the improvement of Moccasin River or Contentnea Creek during the present fiscal year:

Before detailing the progress of the work, I beg to call attention to the condition under which the survey was made and to the impossibility of properly estimating for the improvement required.

The survey was made at the dead of winter during an unusually cold season and when the water was at flood tide. For this no one connected with the survey could be held responsible. Some inaccuracy about the name of the stream occurred in the law of Congress directing the survey, and it could not be made earlier. Congress required information by a certain time and the survey had to be made. This statement is inserted here explanatory of what will be found further on in this report.

On the 14th of September last a small force was started at the mouth of the stream to remove such obstructions as, with the ineffective means at my disposal, could be taken out. The water was lower than ever before known by the oldest inhabitant. No rise took place till November. By the 1st of January, about 4 miles had been partially cleared out. With such appliances as we had, it was impossible to do more. Many logs were removed, trees cut away from the banks and about 750 feet of side dams, made of lumber, were put in, *experimentally*, to confine the water. Here is the proper place to describe this part of the river. For 3 miles from its mouth it traverses a low wooded morass and has absolutely *no banks*. The least rise sends the water over thousands of acres of this flat, and except when there is a considerable rise, these 3 miles cannot be passed by boats of any description. Here lies the only real difficulty in the way of any easy and inexpensive improvement of the river.

On the 1st of January the machinery which had been used on the Neuse between New Berne and Kinston were transferred to the Moccasin, and work was pushed vigorously up the stream. All logs and stumps were taken out and overhanging growth very completely cut away to within 3 miles of Hookerton, a distance of about 25 miles from the mouth of the river. On the 22d of March, the appropriation being nearly exhausted, work was suspended.

During its progress about 2,000 logs were lifted out, 800 stumps pulled up, and 3,000 trees cut from the banks. The amount of small growth, trash, accumulations, &c., removed, was proportionately large.

For your information I quote from a letter of C. E. Foy, president New Berne Board of Trade.

"During the short time the lower part of the stream has been open, over 5,000 bales of cotton have come out of it, and other produce in proportion. A merchant here, partner of one in Snow Hill, tells me that they have carried in wagons, 18 miles, over 2,000 bales of cotton this season which ought to have come down the Moccasin.

* * * * * * *

"These items will give an idea of the benefit of this work to our city and to the people living along this fine stream. * * * I regret that a more complete table or account has not been kept. The next season will show results that none of us would have dreamed of. The country bordering the Moccasin is uncommonly productive, and if the stream be thoroughly opened, incalculable benefit will follow to our city and to the whole region."

The above extracts are founded upon facts.

My own observation and knowledge satisfy me that Mr. Foy's anticipations are none too sanguine if the improvements be made. But the main obstacle to any permanent and valuable improvement must be removed. The estimate of the engineer making the survey made no proper note of the extent and difficulty and importance of this obstacle. It lies within the first 3 miles of the mouth of the stream. This distance must be dredged and diked, and to do it will require not less than from $40,000 to $50,000, and when this work is begun it should not stop till completed, if economy is to be considered.

Open this channel of 3 miles and carry the work to Stantonburg, the limit of navigation, as it has been so far as prosecuted, and 70 miles of a stream, passing through as fine agricultural country as any in the South, will be free for the passage of the abundant and ever-increasing productions of a most bountiful region and virtuous and thrifty people.

This work lies in the second collection district of this State.

Very respectfully, your obedient servant,

R. RANSOM,
Assistant Engineer.

Capt. JAMES MERCUR,
United States Engineer.

I 13.

IMPROVEMENT OF BEAUFORT HARBOR, NORTH CAROLINA.

The river and harbor act approved March 3, 1881, appropriated $30,000 for this improvement.

A project for the expenditure of this sum in the construction of stone jetties for the protection of Shackelford Banks from further abrasion was submitted to the Chief of Engineers October 31, 1881, and by him referred to the Board of Engineers for their opinion.

The project was modified by the Board by the addition of log or brush mattresses for foundations for the jetties, and in this form was approved by the Chief of Engineers.

The absolute location and length of the jetties being dependent upon the effect produced by those first built, it was decided to build them by hired labor.

The absence of facilities at Beaufort and Morehead City for carrying on work of this character, there being no wharves, docks, ship-carpenters, smiths, or repair shops available, no tow-boats or barges to hire, no coal or water supply, and no means of transportation from the railroad at Morehead, except small sail-boats, the necessary preparation for commencing work has been slow and troublesome, but a good working plant is now on hand, and it is hoped that satisfactory progress can be made.

One jetty has been started and 30 feet of it have been built. Arrangements have been made for the supply of stone and timber at favorable prices, and the work is in condition to be pushed forward.

This work has been under the superintendence of Mr. R. Ransom, assistant engineer, a copy of whose report is appended.

Beaufort is a port of entry.

No commercial statistics have been attainable.

Money statement.

July 1, 1881, amount available		$30,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$2,023 08	
July 1, 1882, outstanding liabilities	2,079 83	
		4,102 91
July 1, 1882, amount available		25,897 09
Amount appropriated by act passed August 2, 1882		30,000 00
Amount available for fiscal year ending June 30, 1883		55,897 09
Amount (estimated) required for completion of existing project		22,103 38
Amount that can be profitably expended in fiscal year ending June 30, 1884		22,100 00

REPORT OF MR. R. RANSOM, ASSISTANT ENGINEER.

NEW BERNE, N. C., *June* 30, 1882.

CAPTAIN: By your direction, on the 1st of April I took charge of the projected improvement to be made at Shackleford Point, Beaufort Harbor.

The character of the projected work required appliances none of which could be bought or hired in the vicinity.

It was found impracticable to build necessary scows, &c., by contract in time to get any work done the present season, hence lumber was purchased, labor hired, and two large scows, 60 by 22 feet by 5 feet 6 inches, have been built most substantially and launched, and quarters, &c., nearly completed.

Agreements have been made for the delivery of stone and logs in such quantities as we may require, the stone at not over $3.25 the cubic yard, and the logs at one-half cent the running foot.

The right to prosecute the work upon the point without claim for any value has been obtained, and a fair beginning has been made toward pushing the improvement.

A head has been constructed for the contemplated stone jetty, and mattresses of logs and brush have been laid and covered with stone for 30 feet, and we are ready to push the work. Should no untoward events interfere, within sixty days enough will have been done to show, partially, at least, the probable effect of the intended work.

Circumstances which could not be changed have prevented further progress, every appliance and all materials having to be built or brought from a distance.

The tug hired, and which is indispensably necessary, meets satisfactorily all demands made upon it.

I have been unable to obtain any commercial statistics.

The work lies within the second collection district of this State.

Very respectfully, your obedient servant,

R. RANSOM,
Assistant Engineer.

Capt. JAMES MERCUR,
United States Engineers.

PROJECT OF CAPT. JAMES MERCUR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., October 31, 1881.

SIR: In accordance with authority granted in your communication of the 13th ultimo, I have caused an examination to be made of Shackleford Banks, Beaufort Harbor, and have the honor to transmit herewith a tracing showing the results.

I inclose also six sheets of tracings, reduced to a common scale, for comparison, showing the condition of Beaufort Harbor in the years 1839–'57–'62, and '64–'76–'80, and '81.

From an inspection of these it becomes apparent that the condition of the Shackleford Banks was essentially the same in 1857 as in 1839; that the channel and inner harbor in 1839 was the same as in 1881; that no material changes have taken place at any time in the harbor; but that from about 1857 the point of Shackleford Banks has been worn away so that the high-water mark has retreated on the outside of the point about 1,500 yards, and on the inside about 750 yards. About one-half of this wearing away has occurred since 1876, and the process is now going on quite rapidly, nearly 200 yards having been cut off during the past year.

The main channel is now almost identically the same as in 1839, having in the interval changed its direction on the outer bar through an angle of about 108 degrees, and returned to its straight course, the depth remaining nearly constant.

This indicates that the wearing away of Shackleford Banks up to this time has not materially affected the channel or harbor.

Should the banks, however, continue to wear away and the entrance widen, a new channel would possibly open and the old one deteriorate.

The inhabitants of Beaufort consider a narrow entrance of great value to their town, as tending to break up the storm-waves, which with a wide entrance they fear would sweep directly up to their wharves and endanger the property on the water front.

The recommendation of my predecessor, Captain Phillips, upon which the appropriation was made, had in view protective works for Shackleford Banks and dredging the inner harbor. The estimate for this purpose was $82,000.

In view of information obtained since that recommendation was made, I would respectfully recommend that the total appropriation ($30,000) be expended in protecting, as far as possible, Shackleford Banks, and have the honor to submit the following project for its expenditure, as directed in letter to Captain Phillips from the Chief of Engineers, dated March 19, 1881, viz:

To construct a system of jetties at right-angles to the shore about 300 feet long, and spaced about 300 feet apart in the vicinity of the point, the distance apart increasing to about 600 feet on the straight part of the beach; these jetties to be rooted in the bank above extreme high-water, and to be built from the shore end outward, with a height of about 5 or 6 feet and a base of from 15 to 20 feet; the jetties to be made of riprap, with no stones weighing less than 500 pounds or more than 2,000 pounds; one jetty to be built on each side of the point, and the system to be extended afterward by placing one between these, if necessary, and building additional ones in each direction along the beach at such points as experience shows them to be needed.

Owing to the experimental nature of the work, it is impracticable to draw definite specifications for construction. I therefore recommend that the necessary stone be bought by contract, and that the work be done by hired labor and purchase of material in open market.

The rapid wearing away of this bank renders the permanence of the proposed jetties quite doubtful, from the possibility of the sea eating its way behind them, and also undermining them at their outer ends; but as the protection is needed at once, and the appropriation is entirely inadequate to construct a breakwater, the expenditure necessary to make a trial of the jetties seems justifiable. Should doubts on the subject exist, I would respectfully request that the project be submitted to the Board of Engineers for their judgment.

Very respectfully, your obedient servant,

JAS. MERCUR,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, December 10, 1881.

SIR: I have the honor to submit herewith a report to this office from Capt. James Mercur, Corps of Engineers, of an examination of Beaufort Harbor, N. C., with the view of a project for the application of the appropriation of $30,000 of March 3, 1881, for the improvement of that harbor, and also a report from the Board of Engineers for fortifications and for river and harbor improvements, to whom the question of the improvement of the harbor was referred for consideration.

I concur in the conclusions of the Board, and beg leave to recommend that the appropriation be applied to the protection of Shackleford's Point by jetties, according to the projects of Captains Phillips and Mercur, with the modifications in mode of construction indicated by the Board of Engineers.

Very respectfully, your obedient servant,

H. G. WRIGHT,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

Hon. ROBERT T. LINCOLN,
Secretary of War.

[Indorsement.]

The recommendation of the Chief of Engineers for the application of the appropriation of $30,000 for the improvement of Beaufort Harbor, North Carolina, is approved.

By order of the Secretary of War.

H. T. CROSBY,
Chief Clerk.

WAR DEPARTMENT, *December* 14, 1881.

REPORT OF THE BOARD OF ENGINEERS.

OFFICE OF BOARD OF ENGINEERS FOR FORTIFICATIONS,
AND FOR RIVER AND HARBOR IMPROVEMENTS, &c.,
New York, December 6, 1881.

GENERAL: This Board, to whom was referred by your letter of November 17, 1881, for consideration and report, the whole subject of the improvement of the harbor of Beaufort, N. C., as well as upon the project of Captain Mercur for the application of the appropriation of $30,000 in river and harbor act of March 3, 1881, for the improvement of this harbor, has the honor to submit the following report thereon.

Beaufort Harbor, the first one of importance south of Chesapeake Bay, a distance of over 200 miles, is not only the terminus of the Atlantic and North Carolina Railway, and the natural outlet of the inland commerce conveyed by the neighboring chains of water communication, but is also of great value as a harbor of refuge to vessels overtaken by storms on this, the most dangerous part of the coast of the United States. The bar affords a depth of 15 feet at mean low-tide. This soon deepens sufficiently to give a channel of good width, and nowhere less than 25 feet in depth, to Morehead City, the railroad terminus. The tidal range is here between 3 and 4 feet.

The importance of this harbor was early recognized by the general government. An elaborate survey of it was made by Lieutenant-Colonel Kearney, Topographical Engineers, in 1821; another by Lieutenant Glynn, United States Navy, in 1839; others by the Coast Survey in 1857, 1862–'64, and 1876; and finally by Captain Phillips, Corps of Engineers, in 1880. These charts show a cycle of changes in the bar channel which will soon be noticed in detail.

The formation of this harbor depends upon the action of the sea waves and currents characteristic of the entire coast in the vicinity. The outer sand-bank or cordon-littoral, extending from Ocracoke Inlet by Cape Lookout to Bogue Inlet, a distance of 80 miles, is separated from the main shore by a chain of sounds communicating with Pamlico Sound on the north. The only important break in the entire distance is at Beaufort Harbor, where Newport River, North River, and the sounds in the immediate vicinity afford a tidal reservoir of sufficient capacity to preserve the depth over the bar.

The navigable channel through the cordon-littoral lies between Fort Macon Point on the west and Shackleford Point on the east, the general trend of the coast being east and west from Cape Lookout to Bogue Inlet. The normal width of the opening is about 2,200 yards, the channel always lying near Fort Macon Point since the date of the earliest surveys. A tendency to erode this point was checked shortly before the war by five spur-jetties of stone, of which two now remain intact, two have settled, and one has disappeared.

Shackleford Point, which has never been protected, at present shows a tendency to wear away, thus opening a wider passage and perhaps endangering the depth over the bar by reducing the velocity of flow of the tidal currents. Such action, if not prevented, might also expose the town of Beaufort more directly to injury by waves in great storms.

Although the deep channel through the cordon-littoral has remained for sixty years fixed in position near Fort Macon Point, the bar has undergone great changes.

In 1821 it had a useful depth of about 12 feet, and was situated 2,800 yards due south of Fort Macon Point, the total distance between the points being 2,250 yards.

In 1839 it had shifted its position to the eastward and lay nearly south of Shackleford Point, which had extended to meet it in a southwest direction some 500 yards, the total distance between the points being reduced to 2,100 yards.

In 1857 the surveys showed no marked change. The deep channel passed close to Shackleford Point, which showed little if any wear, and the bar lay southeast of it. The depth also was 13 feet or more.

In 1862–'64 a tendency to swing back appears. The bar was nearly south of Shackleford Point and had retained about the same depth, but the southwestern part of the point had worn away 300 yards. The total width between points, however, was 2,100 yards, as in 1839.

In 1876 the westward movement of the bar had continued, and it was nearly due south from a point 500 yards east of Fort Macon Point. Shackleford Point had worn away on its entire southwestern side some 300 yards. The distance between the points was 2,250 yards, the same as in 1821.

In 1880 the bar remained essentially unchanged, but the erosion of Shackleford Point had continued, the distance between points being 2,600 yards. In September, 1881, Captain Mercur surveyed the point, and found this distance to be 2,900 yards, with evidence of continued wear now in progress, showing a total increase in the opening since 1821 of 650 yards.

Captain Mercur also made some current observations near Shackleford Point which throw light upon the causes of the changes in progress. He found that during the flood a 2 to 3 mile current flows in parallel to the southwest side of the point and sweeps sharply around it to the northeast, moving towards Back Sound. During the first half of the ebb the current flows past the north side of the point towards Fort Macon with a velocity but little exceeding 1 mile per hour; but later it divides, a part continuing in the same direction, while a branch current sweeps along the southwest side of the point with a velocity of about 2.5 miles per hour.

There is, therefore, at present an eroding current steadily at work upon Shackleford Point, which when the main channel passed near it (1839 to 1864) was probably diverted towards Fort Macon, causing an eddy sufficient to build out the shore line.

Summing up the facts above recited, it would appear that for the last sixty years the usual direction of the channel outside the points has been nearly south, but that, perhaps by reason of great storms, sweeping sand from the southwest breakers, it is liable to be diverted toward the east. In the former position Shackleford Point is liable to erosion; in the latter it has been restored. The depth on the bar appears to depend on other causes than this erosion, being now apparently greater than it was in 1821, when the opening was 650 yards narrower than at present.

Within the harbor the only material change since 1821 is the shoaling of the channel leading from Fort Macon Point eastward to Core Sound. A fine channel, nowhere less than 25 feet deep, leads to the natural shipping point, Morehead City, and there appears to be no demand for deepening the old entrance to the Core Sound Channel, near Fort Macon Point. The project of the late Captain Phillips contemplates dredging a new channel 9 feet in depth at low-water, and 200 feet wide, to the wharves at Beaufort, and thence eastward 6 feet in depth and 100 feet wide, to accommodate small craft coming from North River and Core Sound.

This Board has no information as to the probable permanency of such dredgings in this harbor, and it agrees with Captain Mercur that the present appropriation should be applied to the protection of Shackleford Point. It does not appear that the erosion has thus far injuriously affected the depth on the bar, but apprehensions may reasonably be entertained that if the present conditions as to currents continue at the point, such a result may follow.

It is thought that in the construction of the jetties a foundation of brush, mattresses, or timber should underlie the stone. In other respects the project of Captain Mercur meets the concurrence of the Board. The work should be progressive, its extent and details being governed by the effects produced. The present appropriation is probably sufficient.

Respectfully submitted.

Z. B. TOWER,
Colonel of Engineers, Bvt. Maj. Gen.
JOHN NEWTON,
Colonel of Engineers, Bvt. Maj. Gen.
HENRY L. ABBOT,
Lieutenant-Colonel of Engineers. Bvt. Brig. Gen.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

I 14.

IMPROVEMENT OF CAPE FEAR RIVER FROM WIMINGTON TO FAYETTEVILLE, NORTH CAROLINA.

The river and harbor act of March 3, 1881, appropriated $30,000 for the improvement of this river between Wilmington and Fayetteville, N. C.

Provided, That the Secretary of War is directed to expend, of the money hereby appropriated, a sum not exceeding $10,000 to extinguish any claim of right held by any company or corporation to take tolls or make charges for the navigation of so much of said river as is above described: *And provided further*, That said claim of right shall be extinguished and released on or before the 1st day December, 1881, and no part of this appropriation shall be expended in the improvement of said river until such claim of right is wholly extinguished and released: *Provided further*, That nothing herein contained shall be taken or held as a waiver on the part of the United States to the exclusive control of navigation of said river, relieved from any charges or tolls imposed by any company or corporation.

Under this proviso an examination into the value of the franchise of the Cape Fear Navigation Company was made, and a report submitted to the honorable the Secretary of War, under whose authority $10,000 were paid to this company for a deed extinguishing the right to take tolls or make charges for the navigation of the portion of the river between Wilmington and Fayetteville; this deed having been first submitted to and been approved by the Attorney-General of the United States.

The examination, preparation of the necessary papers, and their revision by the law officers of the United States was completed during the high-water stage of the river. No work was undertaken until spring, when the necessary plant was commenced and finished in time to commence work with the June low-water.

Mr. W. H. James, assistant engineer, has been placed in superintendence of this work, in addition to the work on the Yadkin, and directed the construction and work of the necessary machinery with his usual faithfulness and skill. A copy of his report is appended, to which I respectfully refer for further information as to the details of the work, and for statistics of navigation and commerce.

Money statement.

July 1, 1881, amount available		$30,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$14,056 07	
July 1, 1882, outstanding liabilities	757 89	
		14,813 96
July 1, 1882, amount available		15,186 04
Amount appropriated by act passed August 2, 1882		30,000 00
Amount available for fiscal year ending June 30, 1883		45,186 04
Amount (estimated) required for completion of existing project		5,755 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.		5,800 00

REPORT OF MR. WILLIAM H. JAMES, ASSISTANT ENGINEER.

WILMINGTON, N. C., *July* 1, 1882.

CAPTAIN: I have the honor to submit the following report of operations during the year ending June 30, 1882, on "improvement of the Cape Fear River between Wilmington and Fayetteville, N. C."

In the river and harbor bill approved March 3, 1881, appropriating $30,000 for this object, it was provided that "the Secretary of War is directed to expend, of the money hereby appropriated, a sum not exceeding $10,000 to extinguish any claim of right held by any company or corporation to take tolls or make charges for the navigation of so much of said river as is above described: *And provided further*, That said claim of right shall be extinguished and released on or before the 1st day of December, 1881, and no part of this appropriation shall be expended in the improvement of said river until such claim is wholly extinguished and released."

"All claims of right held by any company or corporation to take tolls or make charges for the navigation of so much of said river as is above described," having been extinguished by the payment of $10,000 to the Cape Fear Navigation Company, and by deed from said company, duly approved and recorded, a project was submitted to the Chief of Engineers to expend the balance of the appropriation "in removing snags, logs, and stumps from the channel, and in clearing the banks of overhanging trees, the same to be done by hired labor and purchase of material in open market."

The said project having been approved on the 10th day of June last, the necessary plant having been provided, including a hoister-scow 60 feet long by 24 feet wide, with 16 horse-power double cylinder hoisting-engine, derrick, and the necessary tackle, tools, &c., and also the other required scows, floating quarters, &c. (at a cost of about $3,500), work was commenced at Indian Wells Landing, 37 miles above Wilmington, and during the balance of the month the channel of the river was cleared of stumps, trees, logs, snags, and other obstructions for a distance of 23 miles up river to Little Sugar Loaf Landing, 60 miles above Wilmington and 52 miles below Fayetteville Landing.

In this work 75 trees (mostly large and some very heavy), 164 logs, 92 stumps, and 480 snags were taken out of the channel and properly deposited; of the stumps, five were blasted.

The water being quite low, it was deemed advisable to limit the work at present, and whenever during the season the stage of water is low enough for such work, to removal of obstructions from the channel.

During the continuance of a moderate rise or freshet work can profitably be done in removing or trimming overhanging trees, and late in the fall, when the water is continuously full, that will be the only work that can be done under the existing project. It is hoped that most of the troublesome snags, logs, and stumps in the channel between Sugar Loaf Landing and Fayetteville will be gotten out before winter sets in, as well as a heavy amount of work done in removing overhanging trees.

A survey of this river was made in 1871, when the portion between Wilmington and Fayetteville was carefully sounded, and no material change appears to have taken place since that time in the general character of the river. An examination was also made in January, 1881, for a full report of which reference is respectfully made to the Report of the Chief of Engineers for 1881 (Appendix I 14), in which the general character of the river and improvements needed are set forth and estimates made.

"There is no continuous channel for some 60 miles down from Fayetteville, and to provide one will require the contraction of the waterway."

The $5,000 asked for for experimental dikes would do but a very small portion of this work. The amount required to complete it can only be estimated after careful study and experiment.

To enable steamers to have the benefit of increased depth of water as soon as possible through the 60 miles of river from Fayetteville down, above referred to, I would respectfully suggest that of the next appropropriation made for continuation of this improvement at least $15,000 be allotted for putting in dikes, jetties, and wing-dams, for contracting and deepening the channel in that portion of the river.

Respectfully submitted.

WM. H. JAMES,
Assistant Engineer.

Capt. JAMES MERCUR,
Corps of Engineers, U. S. A.

STATEMENT OF NAVAL STORES, TIMBER, COTTON, AND RICE BROUGHT DOWN THE CAPE FEAR RIVER BY STEAMER TO WILMINGTON, NORTH CAROLINA, DURING THE YEAR ENDING 1ST JUNE, 1882.

WILMINGTON, N. C., *July* 1, 1882.

	Value.
Cotton, 7,954 bales	$237,470
Rosin, 91,923 barrels	147,086
Spirits turpentine, 22,301 barrels	401,418
Crude turpentine, 1,591 barrels	3,182
Tar, 16,621 barrels	33,242
Also in rafts and partly from the Black River, which empties into the Cape Fear 12 miles above Wilmington:	
37,000,000 feet pine timber	260,000
And from Cape Fear:	
Rice, 500 bags	1,000
	1,083,398

A large quantity of naval stores and cotton comes to Wilmington from the Black River via the Cape Fear, and of cotton and naval stores from the Cape Fear by lighters, of which no record is kept that can be reached.

Respectfully submitted.

Wm. H. James,
Assistant Engineer.

Capt. James Mercur.

Exports.

Year.	Cotton.			Spirits.		
	Domestic.	Foreign.	Total.	Domestic.	Foreign.	Total.
	Bales.	*Bales.*	*Bales.*	*Barrels.*	*Barrels.*	*Barrels.*
March, 1881	3,382	2,761	6,143	4,358	4,677	9,035
*Crop year 1881–'82	62,429	63,833	126,262	29,752	58,615	88,367
Crop year 1880–'81	40,767	69,810	110,577	33,121	63,199	96,320
Crop year 1879–'80	36,258	34,214	70,472	26,302	72,599	98,901
Crop year 1878–'79	38,856	64,431	103,287	12,860	95,397	108,257
Crop year 1877–'78	60,267	54,823	115,090	19,573	87,675	107,248

Year.	Rosin.			Tar.			Crude.		
	Domestic.	Foreign.	Total.	Domestic.	Foreign.	Total.	Domestic.	Foreign.	Total.
	Barrels	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
March, 1881	1,724	85,775	87,499	5,250	3,580	8,830	291		291
*Crop year 1881–'82	45,645	380,278	425,923	43,356	12,757	56,113	2,221	102	2,323
Crop year 1880–'81	52,793	392,317	445,110	38,517	11,850	50,367	2,832		2,832
Crop year 1879–'80	39,811	531,683	571,494	44,149	11,900	56,049	3,540		3,540
Crop year 1878–'79	70,495	490,337	560,832	35,186	35,055	70,241	2,797	274	3,071
Crop year 1877–'78	77,486	435,821	513,307	31,733	30,862	62,595	4,772	1,238	6,010

*Cotton from 1st September; spirits, &c., 1st April.

I 15.

IMPROVEMENT OF LILLINGTON RIVER, NORTH CAROLINA.

The act approved March 3, 1881, appropriated $3,000 to the improvement of this river. This appropriation being so small, and the river located at a distance from all works under this office, except the Cape Fear, work upon it was postponed until the beginning of work upon the Cape Fear would enable the assistant engineer superintending that work to supervise this also, with the probability that the machinery employed on the Cape Fear might be used to advantage on this work when, owing to high-water, it could not be used on the Cape Fear, this seeming to be the only way in which any advantageous expenditure of the appropriation could be made.

Work on the Cape Fear having commenced in June, no opportunity to carry out this plan has yet occurred, and no work has been done on the river.

Money statement.

July 1, 1881, amount available	$3,000 00
July 1, 1882, amount available	3,000 00
Amount appropriated by act passed August 2, 1882	3,000 00
Amount available for fiscal year ending June 30, 1883	6,000 00

I 16.

IMPROVEMENT OF TOWN CREEK, NORTH CAROLINA.

The act approved March 3, 1881, appropriated $1,000 to the improvement of this river. This appropriation being so small, and the river located at a distance from all works under this office except the Cape Fear, work upon it was postponed until the beginning of work upon the Cape Fear would enable the assistant engineer superintending that work to supervise this also, with the probability that the machinery employed on the Cape Fear might be used to advantage on this work when, owing to high-water, it could not be used on the Cape Fear, this seeming to be the only way in which any advantageous expenditure of the appropriation could be made.

Work on the Cape Fear having commenced in June, no opportunity to carry out this plan has yet occurred, and no work has been done on the river.

Town Creek is in the collection district of Wilmington, N. C.

Money statement.

July 1, 1881, amount available	$1,000 00
July 1, 1882, amount available	1,000 00
Amount (estimated) required for completion of existing project	8,078 48
Amount that can be profitably expended in fiscal year ending June 30, 1884.	8,100 00

I 17.

IMPROVEMENT OF YADKIN RIVER, NORTH CAROLINA.

The improvement of this river has been carried on during the year in accordance with the approved project for the expenditure of $12,000 appropriated by the river and harbor act of March 3, 1881.

Operations have been conducted by the hire of labor and purchase of material in open market, under the supervision of Mr. W. H. James, assistant engineer, to whom I am indebted for the intelligent and efficient way in which the work has been done. A copy of his report, with the accompanying tracings, is appended, to which I respectfully refer for the details of the work, which are so fully set forth therein as to render it unnecessary to repeat them.

It will be observed that the cost of this improvement, so far as carried out, greatly exceeds the original estimates, and there is no reason to suppose that this relative increase will not hold for the whole of the project originally proposed. In this connection I would respectfully invite attention to the estimates made by Mr. James for the improvement between Oaks Ferry and Douthet's Mill (Eccles Shoal).

These estimates are based upon the results of the work upon the river for the past two years, and are therefore to be regarded as entirely trustworthy. These prices for removing both rock and sand and gravel are high, but necessarily so, as the amounts removed are very small for the area covered, the cutting being frequently limited to a depth of 1 foot or less, and the transportation of removed material very difficult.

The river consisting of a series of ledges and pools, with a rapid fall and a limited flow of water in dry seasons, the simple removal of the ledges would allow the water to escape from the pools and leave the whole river shoal with a rapid current; but as the bottom is largely rock and bowlders, which prevent excessive scour, the removal of the ledges is supplemented by the construction of wing and sill dams below the rapids, which, by backing up the water and breaking up the smooth water-ways, add to the friction of the water in its bed, retard its velocity, and replace the larger rapids, over which there is no channel, by a greater number of smaller rapids over which very light-draught vessels can pass for a great part of the year.

In a few places jetties have been built for the purpose of scouring out a channel through sand and gravel bars. These channels bid fair to be permanent, as the character of the river's bed is such as to prevent excessive scour even with very high velocities.

The observations for the last year show that the entire water supply of the river during ordinary low-water stages is discharged through a channel from 3 to 3½ feet in depth, and at extreme low-water of 1 foot in depth. Whilst a greater depth of course can be carried at the high stages, it manifestly can only be obtained at the low stages by holding back the water by some system of slackwater navigation at a very great expense.

No actual operations for the removal of the mill-dams have yet been commenced, the manner in which $6,000 appropriated for their removal should be expended not having been decided. This is now under consideration.

The following papers are appended, viz:

Report of Mr. W. H. James, assistant engineer.
Eleven tracings showing location of mill-sites and ledges.
Ten tracings of mill-sites.
Twenty-three tracings of ledges.

Money statement.

July 1, 1881, amount available	$43,619 11	
Amount received from sale of wood to Capt. James Mercur	22 50	
		$43,641 61
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	24,246 97	
July 1, 1882, outstanding liabilities	1,459 44	
		25,706 41
July 1, 1882, amount available		17,935 20
Amount appropriated by act passed August 2, 1882		25,000 00
Amount available for fiscal year ending June 30, 1883		42,935 20
Amount (originally estimated) required for completion of existing project		11,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		11,000 00

REPORTS OF MR. WILLIAM H. JAMES, ASSISTANT ENGINEER.

1.

SALISBURY, N. C., *July* 1, 1882.

CAPTAIN: I have the honor to submit the following annual report on the improvement of Yadkin River, North Carolina, during the year ending 30th June, 1882.

Operations were carried on with but little interruption from freshets or bad weather from 1st July, 1881, to late in December, 1881, when work, excepting repairs and care of government property, was suspended until late in February, 1882, when it was resumed and continued without hinderance until 30th June, 1882.

Herewith are submitted traced maps as follows: A general map of the river on a scale of 6,000 feet to 1 inch, showing the location of all ledges cut through and to be cut through between the North Carolina Railroad Bridge and Douthet's Mill, and of all the mill-dams to be passed between the North Carolina Railroad Bridge and the foot of Bean Shoals. Also maps Nos. 2 to 10, inclusive, of the above-mentioned mill-dams and approaches, No. 2 of Peeble's Mill-dam, No. 3 of Hartley's, and No. 4 of Grimes's dam, drawn to a scale of 100 feet to 1 inch, Nos. 5, 6, 7, 8, 9, and 10 being to a scale of 400 feet to 1 inch. No. 1 of Swicegood's Mill property was sent to you last winter by Mr. Whitford with maps of ledges Nos. 1 to 14, inclusive, all to a scale of 100 feet to 1 inch. I also send you traced maps of ledges No. 4 of "Clinton Shoals," Nos. 5 and 6 of Simmison's upper and lower fish dams; No. 7 of Swicegood's Creek ledges, No. 8 of Motley's Shoals and Boone's Ford, No. 11 of Dutchman's Island Shoals, and No. 14 of Big Rock Shoals, all drawn to a scale of 100 feet to 1 inch, showing the wing-dams, jetties, and training walls built at those points. I also send you maps of ledges Nos. 15 to 23, inclusive, between Hairston's Ferry and the foot of Douthet's Mill-dam, all drawn to a scale of 100 feet to 1 inch.

During the year a channel for steamers and bateaux drawing not more than 2 feet of water has been made navigable for from eight to eight and a half months of the year of ordinary rain-fall, from "Old Road Bridge" to the foot of "Click's Fish-dam," a distance of 12 miles above the North Carolina Railroad Bridge, except a few days' work to be done at the head of Swicegood's Creek Shoals. A large amount of work has also been done between the last-named point and Swicegood's Mill-dam. Surveys and maps have been made of all the mill-dams, ten in number, between the North Carolina Railroad Bridge and the foot of Bean Shoals; also surveys and maps, twenty-three in number, made of all shoals where work to any extent was required from the North Carolina Railroad Bridge to the foot of Douthet's Dam ("Eccles' Shoals"), about 25¼ miles above the said bridge.

We have worked for 1 foot depth of water below the dead low-water of the summer of 1881, the lowest known for forty-five years past.

Tide-gauge observations, taken at "Hairston's Ferry" throughout the year, show that 2 feet above that dead low-water mark is the average low-water from eight to eight and a half months of years of average rain-fall at that point and for many miles above and below. We have to go about 3¼ feet below assumed average low-water in cutting through ledges to avoid leaving sharp and dangerous rock points standing above the 3-feet depth required. To go 1 to 1½ feet still deeper with the view of securing navigation throughout ordinary years, would involve an enormous outlay entirely disproportioned to the benefits secured.

The work done is as follows: A channel 60 feet wide opened through "Big Rock Ledge" (see map No. 2), one-quarter mile above Sowers' Ferry; also, through "Deep Hole Ledge" (No. 3), and two other ledges between "Sowers' Ferry" and "Hannah's Ferry." A channel 70 feet wide through Clinton's Shoals (No. 4), where 300 feet of solid rock was cut through and a great number of large bowlders blasted and removed for 400 feet below this point; also, two jetties, or wing-dams, put in to check the current and lengthen slopes.

A channel of 40 feet wide was cut through ledges as Simmison's upper and lower fish-dams (Nos. 5 and 6), and three wing-dams put in at each point for checking current. At Swicegood's Creek ledges (No. 7), a channel 70 to 120 feet wide at apex of angle and 40 feet wide at upper end has been cut through, and wing-dams, one 60 and another 72 feet in length, have been built to check and give proper direction to the current.

At Boone's Ford (Motley's Shoals, map No. 8), a channel of 40 to 60 feet width has been cleared, and three wing-dams 25, 35, and 40 feet lengths and 135 feet of training-wall put in to wash out channel at Boone's Ford and to give proper direction to channel current.

At Click's Fish-trap, one-half mile below and at a ledge one-quarter mile below "Click's Ferry," channels 25 feet wide have been cut through. Not very much more work is needed at these points. At "Dutchman's Island Shoals" (map No. 11) a channel 40 feet wide has been opened, and three wing-dams and 180 feet of training-wall put in to wash out channel; also, a jetty 60 feet long from right bank to a little above the head of island, to force current into main channel. At Bull Hole Ledge a channel 40 feet wide has been cut through. (See general map for location; also map No. 12 of ledges.)

At Barnes' Fish-trap, three and a half miles below Hairston's Ferry, a channel 25 feet wide has been cut through and a few bowlders removed. Considerable work remains to be done here.

At "Big Rock Shoals" (see map No. 14) a channel of 25 feet to 40 feet width has been opened, and three wing-dams built for washing out channel.

At Swicegood's Mill (see map No. 1 of mill-dams furnished last winter, with 14 original maps of ledges) about 600 cubic yards of rock has been blasted in channel proposed and piled up on either side.

In the work before described there has been 4,468 cubic yards rock blasted and removed, 1,907 linear feet wing-dams and training walls built; 2,247 blasts fired; 3,395 pounds dynamite used; 125 cubic yards timber and brush put in dams at Clinton and Swicegood shoals; 10 cubic yards gravel plowed and scraped away at Motley Shoals.

The wing-dams and training walls were constructed of rock, with timber and brush foundations when necessary.

A great number of bowlders were taken out from the channel (many of which required blasting) between the various ledges passed, and much time was consumed in searching for such bowlders. The velocity of current at Clinton Shoals at average low-water assumed is 3½ miles per hour.

At Simmison's lower fish-dam at same stage, 2.14 miles per hour.

At Simmison's upper fish-dam at same stage, 2.05 miles per hour. At Boone's Ford at same stage, 2.25 miles per hour.

A considerable portion of the rock used in dams and training walls was transported from 1,200 to 1,800 feet. It is estimated that the balance of appropriations remaining will continue and complete the improvement up to Oaks Ferry, about 23 miles above the North Carolina Railroad Bridge, exclusive of the amount to be paid to Swicegood for destroying his water-power.

Mill-dam No. 1, see map.

Following is an estimate of the cost of continuing the improvement from Oak's Ferry up to the foot of rapid at Douthet's Mill (Eccles' Shoal), as follows:

For passing ledge No. 17:	
Two wing-dams, containing 300 cubic yards rock, at $3	$900 00
Blasting, removing loose rock, 25 cubic yards rock, at $3	75 00
For passing ledge No. 18:	
Dredging and removing sand and pebbles, 100 cubic yards, at $2	200 00
Rock excavation and removal, 50 cubic yards, at $3.50	175 00
For passing Peeble's Mill-dam, No. 2:	
Rock and logs to be removed from dam, 66 cubic yards, at $3	198 00
Dredging of sand and pebbles from dam, 200 cubic yards, at $1	200 00
Rock excavation and removal, 100 cubic yards, at $3.50	350 00
Wing-dams of rock, 400 cubic yards, at $3.50	1,400 00
For passing ledge No. 19:	
For dredging pebbles and sand, 75 cubic yards, at $2	150 00
For rock excavation and removal, 150 cubic yards, at $3	450 00
For passing Hartley's Mill-dam, No. 3:	
For rock and logs to be removed from dam, 75 cubic yards, at $3	225 00
For dredging sand and pebbles, 300 cubic yards, at $1	300 00
For wing-dams, 300 cubic yards, at $3.50	1,050 00
For rock excavation and removal, 51 cubic yards, at $3.50	178 50
For passing ledges Nos. 20 and 21:	
Removal of old fish-dam, 50 cubic yards, at $2	100 00
Rock excavation and removal, 10 cubic yards, at $3.50	35 00
At No. 21, for blasting and removing rock, 25 cubic yards, at $3.50	87 50
For passing Grimes's Mill-dam, No. 4:	
For rock and logs to be removed from dam, 75 cubic yards, at $3	$225 00
For dredging sand and pebbles, 100 cubic yards, at $1	100 00
For rock excavation and removal 200 cubic yards, at $3.50	700 00
For wing-dams, 600 cubic yards, at $3	1,800 00
For passing ledge No. 22:	
For rock and timber to be removed from old fish-dam, 50 cubic yards, at $2.	100 00
For four wing-dams, containing 600 cubic yards rock, at $3	1,800 00
For rock excavation and removal 100 cubic yards, at $3.50	350 00
For passing ledge No. 23:	
For four wing-dams, containing 600 cubic yards rock, at $3	1,800 00
For excavation and removal 100 cubic yards, at $3.50	350 00
For dredging sand and pebbles, 100 cubic yards, at $1	100 00
Also for blasting and removing from channel between ledges, and hedges and dams, loose bowlders from Oaks Ferry to foot of Eccle's Shoals, 400 cubic yards, at $3.50	1,400 00
	14,799 00
20 per cent. for contingencies, engineering, &c	2,959 80
Total estimate for work from Oaks Ferry to Douthet's	17,758 80

The damages claimed by mill owners up to Douthet's Mill are, as near as can be ascertained, as follows:

By Swicegood	$2,500 00
By Peebles	2,500 00
By Heartley	5,000 00
By Grimes	2,500 00
Total	12,500 00
Amount appropriated for purchase of dams, act of 14th June, 1880, was	6,000 00
Leaving amount unprovided for purchase of dams up to Douthet's	6,500 00

Amount as before stated required in addition to appropriations made to complete under existing project up to the foot of Eccle's Shoals, at Douthet's Mill, is	17,758 80
Additional amount required for purchase of mill-dams up to that point	6,500 00
Total additional amount required over appropriations to carry improvements up to Douthet's Mill	24,258 80

For a general description of the river and the dams crossing it from the North Carolina Railroad Bridge up to the foot of Bean Shoals, reference is respectfully made to the Report of the Chief of Engineers for 1879 (Appendix G 16).

The mill-dams are in about the same condition as therein described (page 647), except that Jones's mill was burned a year since, and that Douthet is building a grist-mill adjacent to his saw-mill.

For further information, reference is also respectfully made to the Report of the Chief of Engineers for 1881 (Appendix I 17).

Up to Douthet's Mill, it is believed that improvement can be carried without difficulty and with benefit to the country on the river, but from Douthet's Mill upward, an inspection of the map accompanying will show some very heavy slopes difficult and extremely expensive to overcome, and unsatisfactory when completed.

The orignal estimate (in the Report of the Chief of Engineers for 1879, Appendix G 16, above referred to), for improvement from foot of Eccle's Shoals up to the foot of Bean Shoals was	$50,394 06
With 15 per cent. added for contingencies, &c	7,559 11
Total	$57,953 17

A heavy addition to the amount would evidently be required to complete the improvement up to Bean Shoals.

The claims for destroying water-power will be about as follows:

Damages claimed, Douthet's	$2,500
Damages claimed, Laughenhour & Neason's	3,000
Damages claimed, Bitting & Carver's	2,500
Total	8,000

Surveys from Douthet's to foot of Bean Shoals are not sufficiently advanced to afford data for a revised estimate that portion of the river.

Respectfully submitted.

Wm. H. James,
Assistant Engineer.

Capt. James Mercur,
United States Engineers.

2.

Salisbury, N. C., *July* 21, 1882.

Captain: Following is a statement of the principal agricultural products for the present year, as nearly as can be ascertained and estimated, of the country lying along the Yadkin River, that would seek a market by way of said river if it were improved under existing project from the North Carolina Railroad Bridge up to the foot of Bean Shoals, 64½ miles, viz:

Indian corn	bushels	668,750
Wheat	do	199,643
Oats	do	302,693
Rye	do	9,500
Buckwheat	do	402
Barley	do	65

Tobacco	pounds	552,201
Cotton	bales	491

Very respectfully, your obedient servant,

WM. H. JAMES,
Assistant Engineer.

Capt. JAMES MERCUR,
Corps of Engineers, U. S. A.

I 18.

IMPROVEMENT OF GREAT PEE DEE RIVER, SOUTH CAROLINA.

The act of March 3, 1881, appropriated $6,000 for the improvement of this river between Little Bluff and Cheraw. Under the approved project this has been expended between the points named, by the purchase of material and hire of labor in open market.

During July the work was carried on by the use of a floating derrick worked by hand, and consisted in removing sunken trees and logs from the river. Some of the trees being very large, the work progressed slowly, and authority was obtained to employ a steam hoister, which commenced work in August and continued until October, when so many of the crew were disabled by the malarial fevers that the work was stopped.

The steam hoister drew too much water to work to the best advantage at all stages of the river, but did good service in removing some pile obstructions remaining since the war, and in taking out the large trees near Bostick's Landing, Tiger Head, Woodstone, and Castaway Ferry, a good steamboat channel being secured at each of these places.

Many of the trees removed were found to be completely petrified, and had to be broken by blasting before they could be lifted.

In November some work with the hand derrick was done between Little Bluff and Castaway Ferry, and in December a gang of twelve men was employed in trimming the banks. In January, 1882, owing to the near exhaustion of the appropriation, all work was stopped and the plant laid up under charge of watchmen at Fountain's Landing.

The work so far done has benefited the navigation of the river, but it is still obstructed by sunken trees and snags, and by the growth of trees on the banks.

This work has been under the superintendence of Mr. H. Heth, a copy of whose report is appended, to which I respectfully refer for a statement of the shipments over the river.

This river is in the collection district of Georgetown, S. C.

The appropriations for this work have been:

June 14, 1880	$7,000
March 3, 1881	6,000
August 2, 1882	6,000

Money statement.

July 1, 1881, amount available		$6,784 57
July 1, 1882, amount expended during fiscal year exclusive of outstanding liabilities July 1, 1881	$6,574 99	
July 1, 1882, outstanding liabilities	89 68	
		6,664 67
July 1, 1882, amount available		119 90
Amount appropriated by act passed August 2, 1882		6,000 00
Amount available for fiscal year ending June 30, 1883		6,119 90
Amount (estimated) required for completion of existing project		6,520 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.		6,500 00

REPORT OF MR. H. HETH, ASSISTANT ENGINEER.

GEORGETOWN, S. C., *July* 11, 1882.

CAPTAIN: I have the honor to submit the following report of work done on the Great Pee Dee River from July, 1881, to July, 1882.

During the month of July, 1881, the work was pushed ahead at "Tiger Head," a bend in the river filled with fallen and sunken trees, many of which were found to be 60 and 80 feet long, and from 4 to 6 feet in diameter. During July the work progressed slowly, the only mechanical appliance for raising these heavy trees being a scow derrick fitted up with a hand-winch. Early in August the steamer Marion was hired by the government and commenced work at Bostick's Landing, where a number of sunken trees were taken up, also a number of piles, driven down to obstruct the navigation of the stream during the war, were removed.

During September the steamer Marion, taking advantage of a temporary rise in the river, ascended as far as "Tiger Head," and completed the heavy work at this point. A good channel for steamers was obtained at this point, also at Woodstone, Bostick's, and Castaway Ferry. Many of the logs had to be blown to pieces, powder being used, and were found perfectly petrified. The river, up to the month of October, continued so very low that the *Marion* drawing 4 feet water was unable to do the work she otherwise would have done. In October, owing to sickness (fever) among the employés, and the river continuing to fall, work with steamer was suspended.

In November, 1881, work was continued with derrick between Little Bluff and Castaway Ferry. The appropriation running low all hands except twelve men were discharged, who were kept at work during the month of December, clearing the banks of overhanging trees and obstructions to navigation.

In January, 1882, all hands were discharged except the necessary guard, and the plant since that time laid up at Fountain's Landing.

The steamer Marion was the only available boat that could be hired for this work; she proved to draw too much water and was too unwieldy for work in a narrow and shallow river. Notwithstanding these drawbacks she did some excellent work, and it is satisfactory to know that the work accomplished has given entire satisfaction to the pilots and captains of the steamers plying on the Great Pee Dee.

The following are believed to be the shipments of produce down the Pee Dee annually:

Timber, feet	36,000,000
Cotton, bales	38,000
Naval stores, barrels	120,000
Shingles	80,000,000

The commerce of the river is sufficient to give employment to two steamers.

The Great Pee Dee is in the collection district of Georgetown, S. C.

Respectfully,

H. HETH,
Assistant Engineer.

Capt. JAMES MERCUR,
Corps of Engineers, U. S. A.

I 19.

IMPROVEMENT OF WACCAMAW RIVER, SOUTH CAROLINA.

The river and harbor act of March 3, 1881, appropriated $10,000 for continuing the work on the river.

The expenditure of this sum has been carried on in accordance with the approved project in strengthening the old jetties, building new ones, removing sunken logs and trees, and trimming the banks of overhanging trees, and those liable to fall into the river.

The work has been carried on by hired labor and the purchase of materials in open market, the pile-driving and hoisting trees being done by a steam hoister hired for the purpose, and the banks cleared by gangs of laborers under suboverseers.

The action of the jetties has been assisted when necessary by the scouring effect of the wheel of a tug-boat, which was moored so the water was thrown by its wheel on the points where scouring was needed.

The effect of the jetties and tug-boat has been satisfactory, having secured a depth of 12 feet of water on the Needle's Eye and Oat bed shoals, which were formerly very troublesome.

The channel in the upper river still contains several shoals; only about 6 feet can now be carried over Cox Shoal, which is the highest point at which jetties have been built. These as well as some other jetties need filling to make them effective; but it is proposed in some cases to make them tight by sheet piling, as being cheaper, more nearly water-tight, and promising greater endurance than log and brush filling.

The appropriation being nearly exhausted all operations were suspended on the 31st of May, 1882.

This work has been under the superintendence of Mr. H. Heth, assistant engineer, to whom I am indebted for the faithful manner in which it as well as the other works under his supervision has been carried out. A copy of his report is appended, to which I would respectfully refer for further details of the work and the shipments by the river.

The Waccamaw is in the collection district of Georgetown, S. C.

Total amount appropriated for this work is $29,400.

Money statement.

July 1, 1881, amount available	$19,045 20
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	18,433 17
July 1, 1882, amount available	612 03
Amount appropriated by act passed August 2, 1882	4,400 00
Amount available for fiscal year ending June 30, 1883	5,012 03

REPORT OF MR. H. HETH, ASSISTANT ENGINEER.

GEORGETOWN, S. C., *July* 11, 1882.

CAPTAIN: I have the honor to submit the following report of work done on the Waccamaw River during the past year. The work has been on the following shoals:

Mount's Landing Shoal.
Jackson's Bluff Shoal.
Dennis's Fish-Hole Shoal.
Indian Creek Cut-off.
Between the mouths of Indian Creek.
Indian Creek Shoal.
Cox Shoal.
Additional work on Needle's Eye Shoal and Oat bed Shoal.

The object of the work on these shoals has been to procure a depth of 12 feet of water. Dredging was proposed in the original project submitted by Captain Phillips, but it was found, after advertising for dredgers, that the amount appropriated was not sufficient at any one time to justify the owners of dredging machines to encounter the risk of bringing their dredges so far. The only plan left was to try the effect of jetties, which was carried out on all the shoals in pretty much the same manner, being modified in structure as the shoals varied.

The plan consisted in driving a double row of piles from each bank and filling in between the piles with logs and brush, thus contracting the volume of water on the shoal, and at the same time accelerating it. When the water thus contracted failed to scour out the channel to a requisite depth, a steam-tug was used to deepen the channel. The combination has always proved satisfactory, and the two shoals, which gave much trouble to shippers and ship-owners, are now readily passed over by vessels drawing 12 feet of water, namely, "Needle's Eye Shoal" and "Oat bed Shoal." The driving of piles has been pretty much completed on all the shoals mentioned above; on several of them no filling has been put in, which leaves them practically useless. This fact is due to the appropriations having been exhausted.

In addition to the work above mentioned, a large amount of work, equally necessary for the navigation of the river, has been done; that is, clearing the banks of overhanging trees. The Waccamaw, as you ascend towards Conwayborough, the head of steam navigation, becomes narrow though deep, and the bends are frequent and very sudden;

hence it becomes absolutely necessary to trim the trees well back in these bends. large number of sunken trees and timber rafts have been taken from the stream. Th work of driving piles and clearing the stream of sunken obstructions was performed b Captain Daggett, from whom the government hired by the day a steamer rigged u with steam hoister and pile-driver.

The following shipments have been made down the Waccamaw during the pas year:

Feet of lumber	21,000,00
Barrels naval stores	130,00
Tierces of rice	5,00
Bales of cotton	30,00
Shingles	1,000,00

A number of schooners are regularly employed between northern ports and Po Bluff on the Waccamaw carrying these products to market; five steamers are employe more or less of their time in the trade of this river.

The Waccamaw is in the collection district of Georgetown, S. C.

Very respectfully,

H. HETH,
Assistant Engineer.

Capt. JAMES MERCUR,
Corps of Engineers, U. S. A.

I 20.

IMPROVEMENT OF SANTEE RIVER, SOUTH CAROLINA.

The act of March 3, 1881, appropriated $22,000 for "improving Santee River by deepening and straightening its outlet to Winyah Bay through Mosquito Creek."

Under authority of the Chief of Engineers a survey of this creek was made and a project for the expenditure of the appropriation, based upon its results, submitted to the Chief of Engineers and approved by him and the honorable the Secretary of War.

This project contemplated making two long cuts 30 feet wide at top and 6 feet deep through marsh land belonging to private parties, and replacing the county bridge by a draw-bridge, and contained a proviso that no work should be done until the right of way through this land should be granted free of cost to the United States, and reasonable bids for the execution of the work received.

The projected work becoming known to the rice planters on the Santee, a great opposition to its execution was developed on the part of some of them, for fear that the straightening of the creek should lead to the introduction of salt water in their rice canals. Petitions from these parties having been submitted to the honorable the Secretary of War, all work was suspended until this matter could be investigated.

A series of tidal observations for one lunar month was taken, the relative levels established, and the tidal currents through the proposed canal computed, showing that there was no reasonable grounds to fear that more salt water would penetrate the Santee than did before the improvement was made.

Opposition was also encountered in running one of the proposed cuts near the dwellings on South Island, and at the request of the residents, no objections in an engineering point of view existing, the route was changed by the authority of the honorable the Secretary of War, so as to make two short cuts instead of one long one.

Papers granting right of way by the route as at present adopted have been furnished by the parties owning the land through which the proposed improvement runs, and have been forwarded to the Chief of Engineers to be submitted to the Department of Justice for their examination and approval.

When the right of way is given to the satisfaction of the law officers of the government, it is proposed to advertise for proposals to do the work required for connecting the Santee with Winyah Bay by contract, the enlargement of the cuts and the deepening of the creek and cutting off some projecting points being postponed until further appropriations are made.

This work is in the collection district of Georgetown, South Carolina.

The appropriations for this work have been:

March 3, 1881	$22,000
August 2, 1882	20,000

Money statement.

July 1, 1881, amount available	$22,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	1,372 94
July 1, 1882, amount available	20,627 06
Amount appropriated by act passed August 2, 1882	20,000 00
Amount available for fiscal year ending June 30, 1883	40,627 06
Amount (estimated) required for completion of existing project	62,427 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	62,500 00

I 21.

IMPROVEMENT OF WATEREE RIVER, SOUTH CAROLINA.

The act of March 3, 1881, appropriated $8,000 for this river. Work during the year has been carried on in accordance with an approved project for clearing out the river by hired labor and purchase of material in open market, with a view to ultimately securing a depth of 4 feet at low-water.

After the stoppage of work on the Pee Dee the steam hoister which had been employed there was hired to work on the Wateree, and commenced operations in January, 1882. She continued working until April 29, 1882, when she was entirely disabled by the explosion of one of her boilers. No other hoister being available, work from that time to the end of the fiscal year was confined to clearing the banks of overhanging trees.

The work both in the river and on its banks has been restricted to that part of the stream, 8 miles in length, which is below the railroad bridge of the Camden Branch of the South Carolina Railroad. This is a close bridge, and allows only 15.3 feet of head room under it at low-water.

The bridge of the W. C. and A. Railroad also crosses this river about 5 miles farther up, and has a clear head room of 16.9 feet above low-water.

These bridges not only prevent the passage of vessels with masts or smoke-stacks, but have been too low to admit the passage of any hoister or derrick scows which have been available up to this time.

The steam hoister, being employed during the high-water months of the year, could not completely clear the river of logs as she worked up stream, as many logs and trees are not visible at high-water; she therefore removed those which the state of the water allowed, leaving the others for a lower stage.

Mr. H. Heth, assistant engineer, has superintended this work. A copy of his report is appended.

The Wateree River is in the collection district of Georgetown, S. C.

Money statement.

July 1, 1881, amount available		$8,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$7,074 87	
July 1, 1882, outstanding liabilities	775 44	
		7,850 31
July 1, 1882, amount available		149 69
Amount appropriated by act passed August 2, 1882		15,000 00
Amount available for fiscal year ending June 30, 1883		15,149 69
Amount (estimated) required for completion of existing project		36,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.		31,000 00

REPORT OF MR. H. HETH, ASSISTANT ENGINEER.

GEORGETOWN, S. C., *July* 11, 1882.

CAPTAIN: I have the honor to submit the following report of work done on the Wateree River during the year ending June 30, 1882:

In January last the government hired the steamer Marion from Messrs. Cordes and Cole to work on the Wateree. The steamer was fitted up with steam-hoisting apparatus.

The work done on the Wateree has been confined to points between its mouth and the railroad bridges of the Camden branch of the South Carolina Railroad, which crosses the Wateree 8 miles from its mouth. Between the mouth of the Wateree and the railroad bridge the river was found to be very crooked and impassable almost its entire length, from sunken trees and overhanging trees which, at points, would actually meet in the middle of the stream; so not only was it necessary to clear a channel, but to cut away as the boat ascended.

The railroad bridge was finally reached, but a great deal of work remains to be done between the bridge and the mouth.

During the short time the Marion was at work on the Wateree the river was continually rising and falling. The overseer in charge of the work could not work systematically from the mouth up towards the bridge, but was compelled to work on such logs and obstructions as he could reach. The distance, 8 miles from the mouth to the bridge, is one network of sunken logs.

The Marion proved to be too large and unwieldy for this narrow stream, and being a stern-wheel boat could not be turned around and moved from side to side.

The Marion continued work during the months of February, March, and April. Her boiler exploded on the 27th April. A full report of this accident was made. Since then, May, June, and July, up to the present, work equally essential has been carried on, clearing the banks of overhanging trees, and trees which must fall in sooner or later and choke up this narrow and crooked stream.

The head of navigation on the Wateree is Camden, a flourishing inland town with a population of 2,500. The Wateree, some 70 miles below Camden, unites with the Congaree, forming the Santee. The principal productions of the country through which it flows from Camden down are cotton, tobacco, and corn; it is a very rich country. The farmers complain very much at the excessive railroad freights, and are all much interested in the improvement of their river, which I feel assured will be of a great pecuniary benefit to them, giving them water transportation to Charleston, S. C.

I have no means of ascertaining the annual products, or rather the amount of each article produced during the year in the section watered by the Wateree. The Wateree is in the collection district of Georgetown, S. C.

Very respectfully,

H. HETH,
Assistant Engineer.

Capt. JAMES MERCUR,
Corps of Engineers, U. S. A.

I 22.

EXAMINATION OF WHITE OAK RIVER, NORTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., April 19, 1882.

GENERAL: I have the honor to submit the following report upon the examination of the White Oak River, North Carolina, with which I was charged by your letter of March 21, 1881, and by Special Order No. 120, paragraph 13, A. G. O., May 26, 1881.

The examination was made by Mr. J. P. Darling, assistant engineer, whose report, together with a tracing of the part of the river included in the examination, is transmitted herewith.

The White Oak River, whose extreme length is probably between 30 and 40 miles, enters the Atlantic at Bogue Inlet, the southwestern end of Bogue Sound, about 35 miles west of Cape Lookout, and about 25 miles from Fort Macon, Beaufort, N. C.

One of the proposed routes of inland water communication crosses the river diagonally near Swansborough, on a line giving nearly the required depth of 9 feet at low-water, for a distance of about 2 miles. Should this line be adopted, the necessary improvement of this part of the river would be included in the general work of opening the route.

The navigation of the river is now only suitable for open sailboats drawing not more than 3 feet of water, which find their way to a market for the country produce at Beaufort and Morehead City, through Bogue Sound, which only admits of a draught of water of about 2 feet. These boats, which are in general owned by the parties whose produce they carry, afford transportation at cheap rates to all the merchandise carried up and down the river.

Any increase in depth in the river would be of no benefit to them, owing to the shoal water which, with a depth of about 2 feet, extends through a distance of 3 miles on Bogue Sound; I have, therefore, not considered it necessary to submit any project for the improvement of the river.

This river is in the collection district of Beaufort. No statistics as to the amount of commerce could be obtained. Nearest port of entry, Beaufort, N. C.; nearest lighthouse, Cape Lookout; nearest fort, Fort Macon.

I remain, very respectfully, your obedient servant,

JAS. MERCUR,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. JOHN P. DARLING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., April 18, 1882.

CAPTAIN: I have the honor to submit the following report with the accompanying tracing of my examination of the White Oak River, North Carolina, made in accordance with your instructions in the month of December, 1881.

The examination extended to Stella Bridge and post-office, 10.45 miles from the inlet; from this point to the head of navigation, a distance of about 10 miles, there is said to be plenty of water, at least 5 feet.

There is only one town of any importance on the river, Swansborough, which has, I presume, about 500 inhabitants. Stella has a store, post-office, and one or two houses.

The average rise and fall of the tide in the White Oak at Swansborough during the time the gauge was kept there (six days) was 1.3 feet; the difference between the highest and the lowest tide during the same time was 1.8 feet. The east corner of the door-sill of the eastern door of the only brick store at Swansborough is 20.898 feet above average low-water.

There is 5 feet of water on Bogue Inlet Bar, and the same can be carried to Swansborough, 3,200 feet above the bar. From Swansborough up the river for about 3¼ miles the water is still about 5 feet, but above that point there is only about 3 feet to the mouth of the Narrows; from the mouth of the Narrows up there is better water. In two places the channel is narrow, with oyster rocks on each side; one place is just below Swansborough and the other is above Jones's Island, about 4 miles from the bar; by putting stakes on these rocks they can be avoided by vessels coming in there. There are two entrances from Bogue Sound into the White Oak, one below Weck's Island, the other above, through which nearly all the vessels go to Beaufort, N. C.; they do not care to go outside, and as they can only carry 2 feet of water through the sound, I do not see that it would do much good to expend money on the White Oak unless Bogue Sound was improved; therefore, I have made no estimate for improvement.

There are only a few small vessels that trade from this river at present, and they draw only about 2 feet of water. I could get no information as to the amount of shipping, as each man ships his own produce; the principal articles are naval stores, cotton, lumber, and fish.

I think there would be considerable increase in shipping if Bogue Sound was improved; the distance from Swansborough to Beaufort Harbor is estimated at 25 miles.

The White Oak River forms the boundary between Onslow, Jones, and Carteret counties, Onslow being on the west side and the others on the east.

I am, captain, very respectfully, your obedient servant,

JNO. P. DARLING,
Assistant Engineer.

Capt. JAMES MERCUR,
Corps of Engineers, U. S. A.

I 23.

EXAMINATION OF MEHERRIN RIVER, NORTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., January 16, 1882.

GENERAL: I have the honor to submit the following report upon an examination of the Meherrin River, with which I was charged by orders from the Chief of Engineers, under the river and harbor act approved March 3, 1881.

The examination was made under directions from this office during the months of November and December, 1881, by Mr. Charles M. Yeates, assistant engineer, whose report, with three sheets of tracings, are forwarded herewith. The detailed map will be forwarded when completed.

The Meherrin River rises in Lunenburg County, Virginia; flows between Lunenburg and Macklenburg through Brunswick and between Greenville and Southampton counties, Virginia. Passing into North Carolina, it runs through Northampton and Hertford counties and empties into the Chowan about 4 miles above Winton.

Skinner's Bridge, the upper limit of the examination, is a closed bridge. From thence to Princeton Landing, 4 miles, the river is only used for lumber, and is so blocked by booms that any attempted improvement would interfere with this business, or else be very temporary in its effects. From Princeton Landing to Murfreesborough, 5½ miles, the removal of logs and fallen trees and clearing banks would cost about $4,000, and would give a channel of 8 feet at low-water. There is at present very little navigation over this part of the river, and no prospect of an immediate increase if the improvement is made.

Murfreesborough, distant from the Chowan 11½ miles, a town of 650 inhabitants, ships annually 6,000 bales of cotton, 5,500,000 feet sawed lumber, 300,000 logs, and 3,000 long piles, and receives 1,000 tons of fertilizers and general merchandise to the value of $225,000.

Vessels drawing 7 feet now reach Murfreesborough with difficulty at low-water, and the navigation is endangered by sunken logs. The removal of these obstructions would cost about $8,000, and the dredging necessary to secure a 9-foot channel, 80 feet wide, about $4,500; giving the total cost for an improvement below Murfreesborough similar to that in the Blackwater and Nottoway, of $12,500, or for the whole river of $16,500.

This improvement would allow the line of steamers now running between Murfreesborough and the Seaboard and Roanoke Railroad at Franklin, on the Blackwater, to navigate the Meherrin drawing as much water as they now do on the Blackwater, and would allow vessels to load to as great a depth at Murfreesborough as can be carried to sea through the inlets.

The Meherrin River is in the second collection district of North Carolina.

RECAPITULATION.

Cost of improvement above Murfreesborough	$4,000
Cost of improvement below Murfreesborough	12,500
Cost of improvement, total	16,500

Very respectfully, your obedient servant,

JAS. MERCUR,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. CHARLES M. YEATES, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., January 10, 1882.

CAPTAIN: I have the honor of submitting this my report on the examination or survey of Meherrin River, North Carolina, accompanied with three sheets of tracings from the original maps (scale $\frac{1}{3600}$) showing the general topographical features along the river and the depth of water therein.

* * * * * * *

The survey between Murfreesborough and the mouth of the river shows a generally good channel, whose greatest depth is 39 feet; but to get a channel of 80 feet width and 9 feet depth, for which I have estimated, it is necessary to make excavations at four points which are duly illustrated on the tracings. The river was found to contain many logs and fallen trees that hang over and in the channel, thus preventing its use, and many growing trees with branches extending over the channel, so that when the channel sets in close to the shore, as it does in many instances, navigation is deprived of its use.

Below is given an estimate of cost :

Location.	Material.	Quantity.	Rate.	Cost.
Near Wilson's Old Fishery	*Mud and sand.* (Dredging, cub. yds.)	1,666.6	$0 25	$416 60
In first bend below Maddrey's Fishery	do	444.4	25	111 10
Figger's Shoal	do	12,068.8	25	3,022 20
In bend at Sear's barn	do	2,000.0	25	500 00
Between Murfreesborough and mouth of river	Logs and fallen trees	1,114	5 00	5,570 00
Do	Overhanging trees	410	3 00	1,230 00
				10,849 90
Add 15 per cent. for engineering and contingencies				1,627 48
Total				12,477 38

This amount of $12,477.38 is thought to be sufficient to give the Meherrin River an ample channel from its mouth to Murfreesborough.

When the survey was completed to the mouth of the river, * * * I undertook the examination from Murfreesborough as far up the river as the appropriation would allow. That took me to Skinner's Bridge.

In many places between Murfreesborough and Princeton Landing the water is very deep, but were the fallen trees and logs removed there would be an available channel of 8 feet depth: and this would be sufficient for all purposes that would justify navigation above Murfreesborough. Therefore I have not estimated for a dredged channel above that point.

Estimates for improvement are given thus:

Location.	Material.	Quantity.	Rate.	Cost.
Between Murfreesborough and Princeton Landing...	Logs and fallen trees..	525	$5 00	$2, 625
Do....................................	Overhanging trees....	225	3 00	675
				3, 300
Add 15 per cent. for engineering and contingencies.	....	....	......	495
Total	....	....	......	3.795

Thus the total amount estimated for the improvement of the river, so that from Princeton Landing to Murfreesborough there will be an 8-foot channel, and from Murfreesborough to the Chowan River a 9-foot channel, is $16,272.38. About three-fourths of a mile above Princeton Landing a depth of water of only 6 feet is attained, and before Skinner's Bridge is reached the depth is in some places only 4 feet. The river becomes quite narrow, and sunken logs and overhanging trees are in great abundance. From investigations made it is concluded that the improvement of this portion of the river would accrue little interest to others than those parties engaged in the lumber business, and from the very nature of their business, or as it is conducted now, the improvement would be of short duration, and but little time would be required for the channel to be again obstructed by logs and spiles.

The Meherrin River has its source in Lunenburg County, Virginia, and then runs down as the boundary line between Lunenburg and Mecklenburg, thence through Brunswick County, then the boundary line between Greenville and Southampton counties; thence into North Carolina, where it runs through parts of Northampton and Hertford counties and into the Chowan River, about 4 miles above Winton, the county-seat of Hertford. Its principal tributaries in North Carolina are Potecasi and Darby's creeks. The former contributes its waters about half a mile from the mouth of the river, and is wealthy in the vast amount of timber lands through which it runs its long and winding course. The water in this creek is quite deep, and its navigation seems to be impeded or hindered only by the numerous logs that extend out from the shores or cover its bottom.

Darby's Creek, commonly known as Vaughan's Mill Creek, flows into the Meherrin between Murfreesborough and Princeton, and has located upon it seven grist-mills. It is very narrow at its mouth, and is not navigable.

Murfreesborough is the only town on the Meherrin River in North Carolina, and has been commonly called the head of navigation, though steamboats and sailing vessels have frequently been up to Princeton Landing and occasionally 2 or 3 miles beyond. Murfreesborough is a very old town and was generously endowed by nature, but the enterprise of its people has not kept strides with general progression elsewhere. Its population is about 650, having considerably decreased within the last twenty years, but an idea of its business, however, cannot be well derived from its population, since it is a distributing point for a large and prosperous section of country in Hertford and Northampton counties. It contains twenty stores and two flourishing female colleges, and the last four years have brought to its business men more prosperity than was known just previously; and whereas six years ago the annual shipment of 2,000 bales of cotton was regarded with much consideration, the town now ships 6,000 bales. For many years occasional rumors of a railroad to connect the town with the outer world have been heard, but thus far it has all ended in rumor. However, it has two steamboat lines, one a weekly freight line to Norfolk, the other a tri-weekly freight and passenger line connecting with the Seaboard and Roanoke Railroad at Franklin, Va. The annual commerce of the Meherrin River is given thus: Exports: 6,000 bales cotton; 5,500,000 feet sawed lumber; 3,000,000 feet logs; 3,000 long spiles. Imports: Value of general merchandise, $225,000; 1,000 tons fertilizers.

The improvement of the Meherrin River as indicated in the report would be of great benefit to that section of country, and the amount of the estimates could be expended to advantage.

Meherrin River is in the second collection district of North Carolina.

I am, captain, very respectfully, yours,

CHAS. M. YEATES,
Assistant Engineer.

Capt. JAMES MERCUR,
Corps of Engineers, U. S. A.

I 24.

EXAMINATION OF NEW RIVER, NORTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., April 26, 1882.

GENERAL: I have the honor to submit the following report upon the examination of New River, North Carolina, with which I was charged by your letter of the 21st of March, 1881, and Special Order 120, paragraph 13, A. G. O., dated May 26, 1881.

The field work of the examination was carried on by Mr. J. P. Darling, assistant engineer, whose report, together with two sheets of tracings, is forwarded herewith.

New River, which lies in Onslow County, North Carolina, is navigable for vessels drawing not more than 5 feet of water from its mouth at New River Inlet where it enters the Atlantic to 3 miles above Jacksonville or Onslow, the county seat of Onslow County, and also a short distance up the northeast and southwest branches of the river.

The bar at New River Inlet barely admits vessels drawing 5 feet, and as it is composed of shifting sand, the channel is affected by storms both in depth and position.

Any works for the improvement of the bar to be effective would be very extended and costly, and manifestly not justified at this time.

The depth of water in the river is therefore sufficient, and the improvement of the river, if any is undertaken, should consist in widening and straightening the channel.

The only part of the river where this widening and straightening is needed is that indicated on the tracings sent herewith. Mr. Darling has estimated that to secure a channel 150 feet wide and 5 feet deep through the 7,000 feet where the improvement is needed will require the removal of about 80,000 cubic yards of sand and oyster she which, at 25 cents per cubic yard and 15 per cent. contingencies, amounts to $23,000.

Owing to the total absence of facilities for dredging at this point, the difficulty of obtaining fuel and water, and the great risk attendant upon taking dredges, scows, and tugs through the inlet, it is probable that the price of dredging would be much higher than this estimate, possibly costing from 40 cents to 50 cents per yard, and increasing price of the work to say $40,000.

The approximate annual shipments from this river are—

Naval stores, 20,000 barrels; cotton, 1,500 bales; together with peanuts, oysters, and fish, no estimate of the quantity of which could be obtained.

New River is in the collection district of Beaufort, N. C. Nearest light-house, Cape Lookout; nearest fort, Fort Macon.

I remain, very respectfully, your obedient servant,

JAS. MERCUR,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. JOHN P. DARLING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., April 21, 1882.

CAPTAIN: I have the honor to submit the following report of my examination of New River, North Carolina, made in compliance with your instructions in January, 1882, with accompanying tracing, two sheets.

After completing the examination of White Oak River, North Carolina, I went to the New River and commenced the examination of said river on the 5th of January, and completed it on the 17th.

New River is in Onslow County; its general course is southerly, emptying into the Atlantic Ocean through New River Inlet. It is a tide-water river for about 6 miles; the upper portion is affected by extremely high-water, but there is very little current. Up to the Narrows the river is very wide, ranging from 2,000 feet to some 3 miles, sometimes bulging out in shallow bays, with a good channel about midway. Just above the inlet large marshes and numerous oyster rocks obstruct the water, forming narrow and shallow channels. The shores are low, mostly fringed with timber, and cultivated back from the river. The tides during the examination were very low; people living on the river said that according to their recollection it had never been lower. At the inlet the average rise and fall of the tide was 2.5 feet; the difference between the highest and lowest tide was 2.6 feet. At Windmill Point the tide rises and falls 1.2 feet, while above the mouth of the rocks there was no perceptible change during the examination.

The bar outside the inlet is constantly changing, the sand drifting during heavy winds. At the time of the examination the channel was on the west side of the breakers in front of the inlet, but was changing to the east near the wreck of an old blockade-runner, where the channel used to be a few years ago, as I am informed. On account of very heavy seas, we were unable, in small row-boats, to take soundings about here or farther seaward.

The inlet from the shore on the west to the long sand bar or beach on the east is 500 feet in width. On this sand bar a base line 895 feet in length was measured, it being the only convenient place I could find; from this base a system of triangulation, including therein the marshes and some of the rocks, was extended to Snead's Ferry, a distance of 5.57 miles. From this point the examination extended to Onslow, a distance of 17.65 miles from the inlet.

There is about 5 feet of water on the bar at ordinary low-tides, although the tracing does not show it, on account of the extreme low-water at the time of examination. Five feet of water can be carried from the inlet to the lower end of the oyster rocks, 2.16 miles above the inlet. From this point to the upper end of the oyster rocks, 7,000 feet, the same depth prevails in the channel, but it is only 50 feet in width, and very crooked, it having been cut so (I think by the State) to avoid the worst rocks, they being visible on both sides at low-water. The tide here, on account of the narrowness, runs very strong. This is the only part of the river in need of improvement at present, taking 5 feet depth as a basis. From the upper end of the rock to Snead's Ferry 5.57 miles above the inlet, there is a good channel, not less than 5 feet in depth and of sufficient width. Snead's Ferry has three stores and about a dozen houses. There are no wharves, and as the water near shore is shallow, vessels load at anchor. From Snead's Ferry to Onslow there is a good channel with deep water, and there are no obstacles to navigation. This portion of the river being very wide, gives good opportunities to sailing vessels.

Eleven thousand one hundred feet below the bridge at Onslow is the mouth of the Narrows, where the river is 1,000 feet wide and gets somewhat narrower before Onslow is reached. The bridge across the river at this place is about 680 feet in length and has a draw about 10 feet wide near the left bank.

Onslow, or Jacksonville, as it is sometimes called, the county-seat of Onslow County, is a place of about 800 to 1,000 inhabitants. A good amount of the produce from this place is carried to New Berne and Wilmington overland in carts. From the lower part of the river oysters and fish in considerable quantities are carried overland to Wilmington. The New River oysters are considered the finest in North Carolina. Small vessels go about 3 miles above Onslow, which is not far from the head of the river.

Seven schooners are running between Wilmington and New River; their average tonnage is 18 tons. The approximate annual shipments, as furnished me by the kindness of Mr. Marine, who has a store on the left bank, one mile above the rocks, are: Naval stores, 20,000 barrels; cotton, 1,500 bales. The quantities of peanuts, oysters, and fish are not noted by him.

I have made an estimate for straightening the channel through the oyster rocks, and making its width 150 feet, with 5 feet of water at low-tide:

Length of cut	feet..	7,000
Increase in width	do..	100
Average amount of bank	do..	3

Amount of dredging required, 80,080 cubic yards of shell and sand, at 25 cents per yard	$20,020
Engineering and contingencies, 15 per cent	3,003
Total	23,023

Very respectfully, your obedient servant,

JNO. P. DARLING,
Assistant Engineer.

Capt. JAMES MERCUR,
Corps of Engineers, U. S. A.

I 25.

EXAMINATION OF WATER CONNECTION BETWEEN WACCAMAW AND CAPE FEAR RIVERS, NORTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., April 14, 1882.

GENERAL: I have the honor to submit the following report upon the examination of "the water connection between the Waccamaw and Cape Fear rivers, with a view of ascertaining if a continuous inland water connection cannot thereby be established," with which I was charged by letter of the Chief of Engineers of March 21, 1881, and Special Order No. 120, paragraph 13, A. G. O., May 26, 1881.

The field work of this examination was intrusted to Mr. John P. Darling, assistant engineer, whose report, together with three tracings, are forwarded herewith.

According to my instructions, Mr. Darling made a connection between the tide water of Livingston Creek and Juniper Creek, a branch of the Waccamaw; also between Little River and the Waccamaw, and ran a line of levels far enough to determine that no low-level connection exists between Town Creek and Juniper Creek.

The results of the examination show that in the localities examined there exists a plateau with an average height above tide water of 50 to 60 feet, constituting what is known as Green Swamp, and indicate that this same plateau is continuous between the lines run.

This indication can only be verified by running a continuous line of levels along this plateau with branch lines running up all streams, or low-lying ravines, which the main line crosses. This line would be about 40 miles long, and would be through a growth of underbrush, which would require clearing with brier-hooks for the greater part of the way.

The expense of running this line would exceed the amount appropriated for the examination. It was consequently omitted.

The character of the country between the two rivers, as developed by the examination and the courses of the little streams which take their rise in it, together with what is known of its general character, leads almost irresistibly to the conclusion that no low-level line exists between the two rivers.

The route examined by Livingston Creek leaves deep water at a point in round numbers 20 miles above Wilmington, and strikes Juniper Creek after a cut of 20 miles; thence there is about 8 miles of Juniper Creek and about 40 miles of the Waccamaw to improve before reaching Conwayborough, the present head of navigation on the Waccamaw.

The Little River route, while much shorter, requires about the same depth of cutting as by Livingston Creek, and two locks. It strikes the Waccamaw at about 25 miles above the head of navigation, at Conwayborough, but to be available as an inland route would require the opening of navigation through the sounds from Smithville to Little River Inlet, a distance of about 35 miles, over a part of which distance there is now no navigation whatever.

Mr. Darling's estimates are made only for the amount required for excavating the main cuts, not including the cost of locks, dams, purchase of land, or the improvement of the connections of the cut with the navigable streams.

The estimates made by Mr. Darling, which are for excavating the prism of the canal only, and amount in round numbers to $1,500,000, $3,250,000, and $8,250,000, respectively, for the three plans mentioned, are based on a bottom width of cutting of 80 feet, with side slopes of 1 vertical to 2 horizontal, and are only given to show that the cost of a canal by either route would be excessive.

It addition to the excavation it will be noted that the Livingston Creek route would require four locks of high lift (14½ feet), founded in soil whose nature is unknown, except that it is either sandy or of clay.

The cost of those locks would be very great; the side slopes of 1 on 2 would not stand on sandy soil, and their protection would be very expensive; to flatten them in such deep cuts would greatly increase the excavation.

The improvement of Juniper Creek from the point at which the canal joins it would probably require a slack-water navigation by locks and dams and the Upper Waccamaw would require similar means, or a great deal of dredging and diking. The method of improvement could only be determined by careful survey.

The same remarks apply to the Little River route as far as side slopes and the improvement of the Upper Waccamaw are concerned. The cost of opening a route through the sounds along the coast cannot be determined even approximately, as the character of the excavation is not known, except that it is partly sand and partly oyster rock, with probable admixture of mud and clay, and owing to lack of surveys the quantity of excavation required is not known.

The cost of locks and dams and the amounts paid for land occupied by canal and flooded by back-water from the dams would also have to be added to the estimates.

The cost of making a water connection between the two rivers by either of these routes would be so great as to be virtually prohibitive. I have therefore not attempted to make detailed estimates upon any of them.

I remain, very respectfully, your obedient servant,

JAS. MERCUR,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. JOHN P. DARLING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., April 12, 1882.

CAPTAIN: I have the honor to submit herewith my report with accompanying tracings, three in number, for "continuous water connection between Cape Fear and Waccamaw rivers, North Carolina," which I made in accordance with your instructions after completing the examinations of White Oak and New rivers, North Carolina. I commenced the examination on January 23, and completed it on March 4, 1882.

From the best information I could obtain, I concluded that a line from Livingston Creek, which empties into Cape Fear River, to Juniper Creek, emptying into the

Waccamaw, would strike the lowest place on the divide, through the Green Swamp. I therefore commenced work at Bannum Landing, the head of tide-water in Livingston Creek, 6 miles above its mouth and 32 miles above Wilmington by water. The creek at this point is about 60 feet wide and 15 to 20 feet deep; small barges and flats carry turpentine from this landing to Wilmington; the swamps on the creek are narrow and the banks are very high, as the accompanying profiles show. From this point I ran a transit and level line up the east side of Livingston Creek, crossing the Wilmington, Columbia and Augusta Railroad about three-fourths of a mile from Bannum's, and one-fourth of a mile west of Brinkley Station; at station 22 the line enters the creek swamp and leaves it at station 55. At station 29, about 1¾ miles from the starting point, I ran a branch line to the creek at Grice's Ford, where the water was found to be 8 feet above high-tide or reference point, then continued the main line from station 29 to station 55, where another branch line was run to the creek, through Mr. Manning's place; the water at this point was found to be 9¼ feet above tide, 3 feet deep, and the creek 25 feet wide.

The main line crosses and leaves the creek at station 78, about 5.9 miles from Bannum's; the water is 25 feet above tide, 2 feet deep, and 25 feet wide. The elevation of the land on the main line to this point, except in the swamp, is from 42 to 49 feet above tide. After leaving Livingston Creek, at station 78, the land gradually rises to an elevation of 52 feet, at station 89.

Crossing Boggy, a small branch of Livingston Creek, running in a southwesterly direction, at station 91, with an elevation of 47.9 feet, the land still rises until station 99 is reached, the outer edge of Green Swamp, where the elevation is 55.2. From this point to station 150, instead of low, wet land, as is generally expected in a swamp, it is high, dry, and nearly level, from 55 to 56 feet elevation. The only reason I could see for calling it a swamp is that it is covered with a dense growth of underbrush, and is said to be covered with water in very wet seasons. The first water found after entering Green Swamp was at Big Swamp Creek, at station 158. The water in this creek is 46 feet above tide and empties into Juniper Creek. At station 161, or 14.9 miles, Honey Island is reached. This island is said to be 5 miles long east and west, by 4 miles north and south; the line runs along the west side of this island to Juniper, crossing several small creeks and swamps, emptying into Big Swamp, which runs nearly parallel with the line and about one-half mile distant on the west side. The highest point on the island is at station 173, where the elevation is 59 feet. At station [illegible] the line enters a cypress swamp.

Juniper Creek is reached at station 208, a total distance of 19.11 miles. At this point the creek is 175 feet wide, and 15 feet deep in the middle; this is one of a series of ponds, or lakes, which form the creek, the connecting streams sometimes drying up in the summer. The elevation of the water in this pond is 31.9 feet above the reference, or the head of tide in Livingston Creek. Station 208, the end of the line, is about miles from the mouth of the creek by land, and about 14 by water, and the creek's mouth is said to be 8 miles by land below Waccamaw Lake.

From a report of C. P. Bolles, civil engineer, on a private survey, I find that the water in Waccamaw Lake is 33 feet above tide in Livingston Creek. The lake is said to contain 35 square miles of water surface, which could be utilized as a feeder for a summit-level canal.

After completing the line to Juniper Creek, I started a branch line from station 161 toward the head of Town Creek, to see if there was a lower elevation to be found in that direction.

After running this line 2.73 miles, and finding the same elevation and the same character of swamp as between stations 100 and 143 of the main line, and learning that it continued about the same for a distance of 5 miles to the head of Town Creek, miles from the head of tide in the same, I concluded that the same high plateau or swamp extended parallel with the two rivers. I therefore abandoned this line, as the only way to find out positively if there was a lower place in the divide would be to run a line of levels down this plateau parallel with the rivers until a low place was found, but as it would take more time and much larger appropriation than was at my disposal, I concluded to go to Little River, South Carolina, about 6 miles above Little River Inlet, and run a line from there to the Waccamaw, with the idea of connecting Little River with the Cape Fear by way of the sound.

I commenced the line about 25 feet northwest of Captain Morse's boat-house, the general course of the line being north 46° west.

I ran a transit line, took stadia distances and levels to the Waccamaw, a distance of 3.48 miles. At station 8¼, distance 3,260 feet, the line crosses a small creek; elevation of water 22.6 feet above low-tide (Little River). This creek empties into Little River about one-quarter mile below Captain Morse's boat-house. Station 11 is the highest point on the line, the elevation being 52 feet. Between stations 25 and 26 the land begins gradually to decline toward the Waccamaw. The only water the line crosses which empties into that river is at station 34, with an elevation of 40 feet.

The elevation of the bank at station 47, where the line terminates on Stanley's place, is 29.11 feet, and the low-water mark in the Waccamaw River is 11.835 above low-tide in Little River. The Waccamaw, where the line terminates, is about 10 feet wide and 10 feet deep.

There is said to be 5 feet of water on Little River Bar at low-tide.

It is impossible to make a detailed estimate for either of these routes without an accurate survey being made. The following are approximate estimates for both summit-level and tide-water cuts, 80 feet on the bottom, with a slope of 2 to 1.

The estimate for the Livingston Creek line is made from Bannum's Landing u the creek to the mouth of Dan Creek; thence across to station 158 at Big Swamp thence down Big Swamp to Juniper Creek. A summit-level canal would require feeder from Waccamaw Lake.

Summit level 29 feet above tide:

	Cubic yards.	
Main cut sand excavation	10,419,892	
Feeder sand excavation	1,368,888	
Total, at 25 cents per yard	11,788,780=	$2,947,195
Engineering and contingencies, 10 per cent		294,719
Total		3,241,914

This summit-level canal would require two locks of 14½ lift each.

Livingston Creek tide-water cut:

Excavating 29,848,078 cubic yards of sand, at 25 cents per cubic yard	$7,462,019
Engineering and contingencies, 10 per cent	746,201
Total	8,208,220

The estimates for the Little River line commence at the mouth of the creek which empties into Little River one-fourth of a mile below the line, and go up that creek to where the line crosses it at station 8¼; thence on a straight line to Waccamaw River at Stanley's, station 47.

Summit level 14 feet above low-tide in Little River, using Waccamaw River a feeder:

Excavating 5,118,552 cubic yards, at 25 cents per cubic yard	$1,279,638
Engineering and contingencies, 10 per cent	127,963
Total	1,407,601

This summit-level canal would require one lock at Little River of 14 feet lift, and two dams at the Waccamaw River.

A tide-water cut would require the excavation of 8,562,986 cubic yards of sand, at 25 cents per cubic yard	$2,140,746
Engineering and contingencies, 10 per cent	214,074
Total	2,354,820

I have made no estimate for either locks or dams, as I have not got information enough as to the character of the river or soil.

I am, captian, very respectfully, your obedient servant,

JNO. P. DARLING,
Assistant Engineer.

I 26.

SURVEY OF BAR AT MOUTH OF WINYAH BAY, NEAR GEORGETOWN, SOUTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., December 22, 1881.

GENERAL: I have the honor to submit the following report upon the survey of the bar at the mouth of Winyah Bay, near Georgetown, S. C., made in accordance with instructions contained in your communications to the late Capt. C. D. Phillips, dated March 21 and May 21, respectively.

The field work of the survey was intrusted to Mr. Charles M. Yeates, assistant engineer, and was by him completed between August 31 and October 15, 1881.

Owing to the continued prevalence of high winds, the work was retarded and rendered so expensive that the money allotted for the survey was expended before as much information as is desirable was obtained; enough, however, was gathered to show that the bar is now in nearly the same condition as when last examined by the United States Coast Survey, namely, 1877.

A comparison of all the charts available in this office shows that the conditions of the bar and entrance have not materially changed since the date of the earliest map, namely, 1855, the most marked differences being a change in the direction of Bottle Channel, and in the south channel, near its outlet, or at the 18-foot curve. These changes are, however, probably temporary in their character and hardly affect the depth of water available for vessels.

A certain amount of permanence is shown by this, which indicates that the present depth is about the normal one, unless changes are made in the outlet which will vary the character of the currents on the bar. It is manifest, since the bar consists largely of shifting sand, exposed to the waves and currents, that no system of dredging alone would give a permanent improvement, and recourse must be had to some other method.

The conformation of the shore in the vicinity of Georgetown entrance is such as to indicate the existence of a littoral current running down the coast during the prevalence of winds from northeast to southeast, between which points are included the storm winds of this coast.

This current, if it exists, would be a great advantage to a system of jetties for improving the entrance, as the natural and shortest course for these jetties to reach deep water throw them in such a direction that the current would sweep across their ends and remove the tendency of the bar to extend beyond them.

The tidal basin included in the bay and lower portion of the rivers which empty into it is quite large, securing a full inflow and outflow of tidal waters, while the amount of fresh water discharged from the rivers is sufficient at all seasons to determine a stronger current during ebb than during flood tides, this giving the greater scour in the right direction.

In the straight portion of the channel between North and South islands there is an available depth of 18 feet and over for a width of 600 yards, this depth and width decreasing when the current begins to lose velocity through spreading and dividing into the three channels across the bar.

If the greater part of the ebb could be directed upon one point of the bar, it would not be too much to expect a resulting depth of entrance of from 12 feet to 15 feet, with a width of 600 yards.

High jetties carried to the 18-foot curve, and extended, if necessary, would undoubtedly secure this end, but at an expense too great to be worth estimating for at this time.

An improvement sufficient to satisfy all reasonable demands of commerce can probably be obtained by the use of submerged jetties in all respects similar to those now being constructed at Charleston, S. C., and at an expense much less than by any other reliable method, with the advantage that these low jetties might be raised above high-water, should it be deemed necessary in the future.

The accurate location of such jetties can only be made after a thorough examination of the nature and constitution of the bar, and of th direction and force of the currents upon it. An approximate location however, shows that the combined length of the two jetties will b nearly 30,000 feet, with an average depth of water of about 8⅓ feet a low-tide.

The Charleston jetties are located in an average depth of about 16 feet, and their estimated cost is $82.26 per linear foot.

The less depth at Georgetown will decrease the cross-section of th jetties, but will add to the difficulty of construction, so that an estimat of $50 a linear foot is perhaps as good as can be made without a full determination of their location. This would give for the cost of improvement about $1,500,000. This estimate is, of course, subject to revisio with more full information.

In the construction of such jetties the north one might be complete and a channel cut through the bar near its outer end; then the sout one could be built, closing the south channels, if it should be found desirable, without interfering with commerce.

As the cost of the work of improvement is so great, and the presen commerce of the port not large, it is apparent that the work should no be undertaken until systematic observations are taken and the locatio and mode of construction of the jetties are well considered.

My thanks are due to Mr. David Risley for information upon the commerce of Georgetown; his letter to Mr. Yeates is forwarded herewith together with Mr. Yeates's report and a tracing of the results of his survey. The finished map will be forwarded when completed.

I remain, very respectfully, your obedient servant,

JAS. MERCUR,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. CHARLES M. YEATES, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., November 4, 1881.

CAPTAIN: I have the honor of submitting this my report on the survey of the bar a mouth of Winyah Bay, South Carolina, accompanied by a tracing from the original ma (scale $\frac{1}{20000}$), showing the character of the bottom, the depth of water at an averag low stage, and illustrating by 6, 9, and 12 foot contours the various sloughs, channel and shoals on the bar.

* * * * * * *

The survey was very much delayed by heavy winds and rough waters, and th rapidity of the current was a source of constant annoyance, since it was impossible t work against tides with oars.

As to the course of the flood and ebb tides, the shapes and positions of the shoal indicated by the contours on the tracing herewith submitted, give an excellent idea The vast volume of water coming down from the rivers that flow into Winyah Ba finds an outlet to the ocean between North and South islands.

These islands form peninsulas between the bay and ocean, and just between the is a channel of excellent depth, thus giving, in nature, an effective idea of the jett system.

The shore line of North Island is approximately straight to its extreme point, bu South Island makes an angle in its shore line near the wharf, and just behind thi angle the ebb-tides have formed Mother Norton Shoal, which extends parallel t North Island shore and seaward for a distance of 2.4 miles. Portions of this shoal ar exposed at very low water.

The main volume of water ebbs parallel to this shoal and between it and Nort Island, while a portion of it on reaching the head of the shoal runs across and ebbs i the general direction of the eastern shore of South Island. The two ebb-current separate on Mother Norton, but the ebb between the shoal and South Island is no nearly so strong as the flood in the same locality, making an unusual decrease in rapidity as the tide approaches low-water.

Another large shoal has been formed with its head near the end of the Mother Norton Shoal, but between it and South Island and following the direction of the tides parallel to the eastern shore of South Island.

The volume of water that ebbs parallel to the western shore of North Island, on reaching the extreme point of the island, there escapes from its narrow confines, and while the greater portion of it runs down on its old course, a part of it runs with great rapidity around the point of North Island, and then takes a northward course about parallel to the eastern shore of the island. The returning flood-tide takes the same course around the point. The result is a small shoal at the inner side of the point, and a little further round the point a deep slough half a mile in length and extending nearly to the outer reef.

The volume of ebb-tide that has continued its southeasterly direction is once more split, and this time at the inner mouth of Bottle Channel, along which it follows to the ocean.

When the ebb-tides reach the sea buoys they have been decreased so much in volume by this widening of their confines that their force is proportionally decreased, and is no longer able to sweep out a channel, and this force which is left is overcome in part by the incoming rollers, which make a deposit of sand.

I was informed by the pilots and steamboat men that there was at this time through the southeast pass a depth of only 7 feet at low-water, but my survey shows me that there is now a channel of 9 feet depth at mean low-water from the inlet across the bar. It is true that there is occasionally at some low-tides only 7 feet across the bar, but that I cannot think is true for an average of low-tides.

Flood-tide currents follow the course of the ebb-currents, except that easterly winds have more influence upon them, and especially those currents in the main channel. Easterly and northeasterly winds cause the flood-tide currents from the outer reef at southeast pass to Fishing Bank buoy to set toward South Island.

So, while the currents spread all over the bar as soon as they pass North Island, there are certain ones that have greater rapidity than others, and a good idea of their courses can be had from observing the sloughs and bars. The bar, then, we may infer, is more subjected to the influences of the tides than to those of the winds.

* * * * * * *

This report is submitted merely as a report of the progress of the survey.

Considerations of improvements, plans, estimates, commercial statistics, &c., will be hereafter submitted in accordance with your subsequent instructions.

The bar at the mouth of Winyah Bay is in the collection district of Georgetown, S. C.

I am, sir, yours, very respectfully,

CHAS. M. YEATES,
Assistant Engineer.

Capt. JAMES MERCUR.

LETTER OF MR. DAVID RISLEY.

GEORGETOWN, S. C., *November* 11, 1881.

DEAR SIR: Yours of October 24 is received. Should have replied sooner, but it required some time to get up the necessary information. In replying we will answer your questions as they are asked.

To the first interrogation:

1. The Waccamaw River has on it landings and villages, Buck's lower mill, a lumber and naval store; shipping point, from which are shipped about 5,000,000 feet of lumber, about 10,000 barrels naval stores, and about 1,000,000 shingles; Waverley, from which are shipped about 5,000 tierces of rice a year; Buck's upper mill, from whence are shipped about 8,000,000 feet lumber and 100,000 shingles; Pott's Bluff, from whence are shipped about 50,000 barrels of naval stores; Conwayboro', the receiving point for the upper river, from whence are distributed 75,000 barrels of naval stores a year, about 30,000 bales cotton, and about 8,000,000 feet of timber. This is the head of schooner navigation, and about 60 miles from Georgetown Bar.

From Conwayboro' to the head of the river, about 75 miles, is an agricultural, timber, and naval-store country.

2. The Pee Dee River has its confluence with Winyah Bay at Georgetown. The first shipping point up this river is Bull Creek, from whence there are shipped annually about 75,000 barrels naval stores, about 10,000 bales of cotton, 2,000,000 shingles, and this is the distributing point for about 10,000,000 feet of timber.

Passing up this river, the next shipping point is Pine Bluff, from whence are shipped about 15,000 bales of cotton and about 5,000 barrels naval stores. Three miles further up is another shipping point, known as Smith's Mill; from this point are shipped abou 5,000,000 feet of lumber, 10,000 barrels naval stores, 2,000 bales cotton. This is th head of schooner navigation, and about 75 miles from Georgetown Bar. From thi upwards the counties of Williamsburg, Darlington, Marion, Chesterfield, Marlborough in South Carolina, and Anson and Richmond, in North Carolina, contribute largely t the freight on this river, which is navigated by light-draught steamers; the towns o Cheraw, Darlington, and Bennettsville shipping by it about 2,000 bales of cotton, th same quantity of naval stores, and large amounts of timber. About 10 miles abov Smith's mill it receives the waters of Lynch's Creek, from which are shipped 20,000 o 30,000 bales of cotton, and 20,000,000 or 30,000,000 feet of timber.

Tributary to Lynch's Creek the counties of Williamsburg, Marion, Darlington, Sumter, Kershaw, Chesterfield, and Lancaster. At Pine Bluff the Pee Dee receives th waters of Little Pee Dee, from which are also shipped large amounts of cotton, nava stores, and timber. And there are tributary to this stream the counties of Horry Marion, in South Carolina, Robeson, Columbus, and Richmond, in North Carolina.

3. Black River. On this river the shipping Point is Potato Ferry, from whence ar shipped about 1,000 bales of cotton, 1,000,000 feet lumber, 2,000,000 shingles. The nex is Harper's Landing; from this point are shipped about 1,000,000 feet of lumber, 10,00 barrels of naval stores, and about 800 bales of cotton. This is the head of steamboa navigation; this river has tributary to it part of the counties of Georgetown, Williamsburg, Clarendon, and Sumter, and has tributary to it Mingo Creek, from whic are shipped 20,000 barrels of naval stores and about 5,000 bales of cotton. On thi stream are located the villages of Potato Ferry, Harper's, Kingstree, and Manning.

4. The Sampit. On this stream is located the town of Georgetown, at its confluenc with Winyah Bay, and, 10 miles above Georgetown, Sampit Bridge. The shipment from Georgetown include those of the Sampit.

5. The Santee and tributaries. On this river and its tributaries are located Gourdins, Rice Bluff, Camden, Columbia, Edgefield, York, Lancaster, and several smalle towns. It has tributary to its waters the larger parts of the counties of Georgetown Charleston, Orangeburg, Lexington, Richmond, Fairfield, Newberry, Lawrence, Chester, Anson, Spartanburg, Anderson, Pickens, and Greenville. And, on the other side York, Lancaster, Chester, Fairfield, Kershaw, Richmond, Clarendon, Sumter, Williamsburg; in fact, three-quarters of the State of South Carolina and several countie of North Carolina are tributary to this river. It is navigable for light-draught steamers from the sea to Camden, on the Wateree River, and to Columbia, on the Congaree distance about 150 miles from its mouth, and the Pee Dee is navigable from the sea t Cheraw, a distance of about 160 miles. Black River from the sea to Potato Ferry about 60 miles.

Interrogation 2 is answered in the foregoing.

3d interrogatory. There are 5 steamboats navigating the Waccamaw, all light draught; average in tonnage not more than 100. There are 7 navigating the Pee Dee all light-draught, averaging about 250 tons. On Black River there are 5 steamboats all light-draught, averaging about 100 tons. On the Santee River 4, averaging 250 tons

4th interrogatory. In lumber the number of cargoes shipped from and throug Georgetown is about 170; the average tonnage of the vessels is 225 tons, making total of 38,200 tons, and a total shipment of 29,000,000 feet; total value of which i about $464,000.

The number of shingles shipped is about 10,000,000; value $99,000. The number o vessels to transport them is about 33, averaging about 200 tons each, making a tota tonnage of 6,600 tons.

The amount of steam tonnage entering this port annually is about 54,000; averag size of the vessels, 300 tons; average number of trips, 175; average value of inwar cargo per trip, consisting of general merchandise, $20,000.

Outward cargo, consisting of cotton, rice, and naval stores, about $22,000; th number of bales of cotton shipped per steamer from this port, about 50,000; of nava stores, about 70,000 barrels; of rice, 12,000 tierces. The number of vessels engage in the naval stores and general merchandise trade between this and New York is 10 average number of trips they make, 95; average tonnage of each, 450 tons; averag value of inward cargo per trip, $30,000; average value of outward cargo per trip $22,000; of corn vessels there are about 40; their average cargoes are about 3,00 bushels; average value, $2,000; average tonnage, about 90 to each.

Interrogatory the 5th is answered in the previous one.

6th interrogatory. The general business of Georgetown is that of importing supplie for the planters in the region; of shipping rice, cotton, and naval stores, of manufacturing and shipping lumber and shingles. Its total exports are about 4,500,000, an its imports of general merchandise are nearly the same.

7th interrogatory. The schooners trading between Georgetown and New York a regular liners average in capacity 450 tons; in draught, 11 feet 6 inches; and they average 10 trips per year; average value of each, about $20,000. There are 10 of them

The vessels carrying lumber are transient vessels, and of about the same average capacity, depth, and value.

8th interrogatory. A railroad will be built from Georgetown to Lane's depot within twelve months, connecting with the South Carolina Central; this is certain.

The business of the town in exports is increasing annually. There are in this harbor 6 steam-tugs; average tonnage, about 40 tons.

Hoping you will find these answers full and satisfactory, I am, dear sir,

Yours, respectfully,

DAVID RISLEY.

CHARLES M. YEATES, Esq.

I 27.

EXAMINATION OF OREGON INLET, DARE COUNTY, NORTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., June 29, 1882.

GENERAL: I have the honor to submit the following report upon the examination of Oregon Inlet, with which I was charged by Special Orders No. 120, dated Washington, Adjutant-General's Office, May 26, 1881.

A preliminary personal examination was made by me on June 22, with a view to a further instrumental survey, if it was considered desirable and the funds available would permit it.

Oregon Inlet connects the ocean with the waters of Pamlico Sound to the eastward of the southern end of Roanoke Island. In its present condition it allows vessels drawing 9 feet to enter at low-water, and those drawing 11 feet at high-water. The entrance is well marked by the breakers on the bar and the beach when a moderate sea prevails, and one properly-located buoy would make it clear at most states of wind and sea. The width of channel between the breakers is about 500 yards. The channel at this time skirts the southern point of the inlet, following a line parallel to the beach, and enters the deep water in a direction nearly southeast, a little to the south of the life-saving station, which is very near the site of the old light-house which formerly stood to the south of the inlet.

After entering the inlet a vessel strikes the Old-house Channel, which for about a mile carries more water than there is on the bar, and which affords a harbor of limited extent to vessels which may lie in it.

At the inner end of the Old-house Channel lies the Bulkhead Shoal, over which there is only about 5 feet of water, and the channel through this "bulkhead" or "swash" is extremely crooked. The bottom within, without, and through the inlet is composed of shifting sands, which move continually under the action of waves and currents, so that the resident fishermen are unable to work a boat drawing 4 feet across the Bulkhead without constant sounding and kedging to find and follow the turns in the channel.

The channel over the outer bar is more constant in its character, but is liable to change in depth and direction at any storm. The local pilot informs me that at one time last winter there was a depth of 14 feet at low-water for some time.

The latest available Coast Survey chart shows the condition of the inlet in 1873, at which date the channel skirted the northern point and opened almost due north, with a least depth on the bar of 6½ feet. An old steamboat boiler which remains from a wreck in or near this old channel is now about one-third of a mile to the north of the present channel.

The extremely unstable nature of the bar, and the great extent, very small depth, and constant shifting of the shoals within would render any attempt at improvement at a small expense entirely futile, and would cause any improvement promising permanence to be enormously expensive.

No instrumental survey of any value could be executed with the limited amount of money available.

I remain, general, very respectfully, your obedient servant,

JAS. MERCUR,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

APPENDIX J.

IMPROVEMENT OF THE RIVERS AND HARBORS ON THE COAST OF SOUTH CAROLINA, GEORGIA, AND THE ATLANTIC COAST OF FLORIDA.

REPORT OF LIEUTENANT-COLONEL Q. A. GILLMORE, CORPS OF ENGINEERS, BVT. MAJ. GEN., U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. **Charleston Harbor, South Carolina.**
2. **Ashley River, South Carolina.**
3. **Wappoo Cut, South Carolina.**
4. **Savannah River and Harbor, Georgia.**
5. **Savannah River, Georgia.**
6. **Savannah River above Augusta, Ga.**
7. **Altamaha River, Georgia.**
8. **Brunswick Harbor, Georgia.**
9. **Entrance to Cumberland Sound, Georgia and Florida.**
10. **Saint John's River, Florida.**
11. **Volusia Bar, Florida.**
12. **Saint Augustine Creek (Thunderbolt River), Georgia.**
13. **Inside passage between Fernandina and Saint John's River, Florida.**

EXAMINATIONS AND SURVEYS.

14. **For the opening of steamboat communication from the Saint John's River, Florida, by way of Topokalija Lake to Charlotte Harbor or Pease Creek.**
15. **Indian River, Florida, at the north end, with a view of opening a passage into the lagoon one-half mile east.**

UNITED STATES ENGINEER OFFICE,
New York, July 29, 1882.

GENERAL: I have the honor to transmit herewith my annual reports upon the works of river and harbor improvement under my charge for the fiscal year ending June 30, 1882.

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Lieutenant-Colonel of Egnineers,
Bvt. Maj. Gen., U. S. A.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

J 1.

IMPROVEMENT OF THE HARBOR OF CHARLESTON, SOUTH CAROLINA.

During the fiscal year ending June 30, 1882, operations for improving the entrance into Charleston Harbor, South Carolina, were carried on in conformity to the plan submitted in my communication to the Chief of Engineers, dated March 9, 1878, and printed in Appendix H of the Annual Report of the Chief of Engineers, 1878.

By this project it is designed to establish and maintain, by means of two jetties, a low-water channel of not less than 21 feet depth across the bar, upon which the greatest available depth has heretofore been only 11½ feet. The estimated cost of the project was $1,800,000.

Previous to the spring of 1878 there had been expended by the general government in the improvement of the ship-channels in Charleston Harbor, subsequent to the close of the civil war (from 1871 to 1878), the sum of $93,700 in taking up the wrecks of fourteen iron-clad and wooden vessels sunk during the war, and in removing a portion of the Bowman jetty projecting into Beach Channel.

RECAPITULATIONS OF OPERATIONS PREVIOUS TO JUNE 30, 1881.

North jetty.—The work of constructing this jetty was begun in December, 1878. On June 30, 1881, the seaward end of the bottom course of the work was at a distance of 12,042 feet from the starting point on the shore of Sullivan's Island, measured along the axis of the work.

The widths of this bottom course varied from 43 feet at the shore to 118 feet at the sea end, and in height from 2¾ to 4 feet, composed of a log and brush mattress, overlaid with riprap stone. A second course of mattresses, varying from 66 feet to 81 feet in width, was laid over the bottom course for a length of 1,648 feet from a point about 7,600 feet from Sullivan's Island seaward, the height of this portion of the jetty being thereby increased to from 5½ to 6 feet. The gap previously left on Drunken Dick Shoal was closed by a foundation course of 1,663 feet in length, 64 feet in width, and from 3¾ to 4 feet in height. South of that shoal the jetty was raised by distributing riprap stone over it. In some places the height thus attained was from 13 to 14 feet from the bottom.

Up to June 30, 1881, the aggregate amount of riprap stone placed on this jetty was 65,514½ cubic yards, and the mattress work of an average thickness of 18 inches, composed of logs and brush, amounted to 111,763 square yards.

South jetty.—The laying of the foundation course of the south jetty was commenced in April, 1880. On June 30, 1881, its seaward end had reached a distance of 6,913 feet from the starting point on Morris Island. It had then crossed the main ship-channel, where the greatest depth was 39 feet at mean low-water. The width of the mattresses varied from 42 feet to 112 feet, and the aggregate thickness of mattresses and stone was about 2¾ feet. The total quantity of riprap stone placed on this work from the beginning of operations to June 30, 1881, amounted to 15,134 cubic yards, all of which was supplied as a component part of the apron foundation. The mattress work of logs and brush used for the foundation amounted to 45,731 square yards, 18 inches thick.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1882.

On July 1, 1881, the sum of $279,340.45 was available for prosecuting the work.

The operations consisted essentially in continuing the work of extending the foundation courses of the north and south jetties, and increasing their height, and in constructing a spur-jetty for the protection of the sea-shore of Sullivan's Island. A considerable amount of field-work was done, including a thorough survey of the inner and outer harbors and the bar

The larger portion of the work on the north and south jetties during the fiscal year just closed was executed under the contract entered into with Mr. E. T. Bangs on June 11, 1881, and referred to in my last annual report. By a supplementary agreement with the same party, dated July 1, 1881, he was to furnish and place upon the log mattresses live hardwood brush at the rate of 17 cents per square yard, 6 inches thick in the finished work.

The contract made on August 7, 1880, with Mr. F. P. Murphy, for furnishing and putting in the work 20,000 cubic yards of riprap stone, at the price of $2.80 per cubic yard, was annulled under authority of the department on April 11, 1881. Arrangements were made with Mr. Murphy's bondsmen by which the balance of the stone required under this contract was procured in open market at $2.80 per cubic yard in the work.

The contract for work on the Charleston jetties, made with Mr. N. A. Devereux on November 6, 1880, was also annulled by authority of the Chief of Engineers on August 4, 1881. He had failed to perform anything whatever toward executing his contract.

It had been anticipated that such a measure would become necessary, and the specifications for work under the appropriation of March 3, 1881, had been drawn up so as to provide for the expenditure of that appropriation, and in the event of Devereux's failure, for the amount set apart for his contract also.

On my recommendation, the Chief of Engineers authorized the work embraced in the Devereux contract to be included in the contract with E. T. Bangs of June 11, 1881.

North jetty.—The work of extending this jetty seaward was continued in the same direction adopted in December, 1880, or upon a straight line bearing south 58 degrees east. On June 30, 1882, the seaward end of the jetty had reached a point 14,361 feet distant from the shore of Sullivan's Island, measured along the axis of the work, and about 1,000 feet inside the 18-foot curve of low-water depths on the outer slope of the bar. Where the mats were laid during the year the low-water depths ranged from 13.5 to 17 feet; at the present terminal point of the jetty the depth is from 13 to 14 feet at mean low-water. The work along the whole distance is continuous and of the full width, although it has not yet been carried to the required height.

The total length of extension during the last fiscal year amounted to 2,319 feet. The width of the mattresses was uniformly 118 feet. The quantity of log and brush mattress 18 inches thick laid in that time amounted to 32,314 square yards.

The crest of the work rises from 2½ to 4 feet above the original bottom.

During the same period 28,387 cubic yards of riprap stone were deposited upon the north jetty.

The aggregate amount of stone placed on the north jetty from the first beginning of operations, in December, 1878, to June 30, 1882, is 93,902 cubic yards, or about 113,200 gross tons; and the quantity of log and brush mattress work 18 inches thick amounts to 144,077 square yards.

South jetty.—The apron foundation of this work was continued on the straight course bearing south 87 degrees east, adopted at the beginning until the end of February, 1882, when the jett yhad reached a point 8,660, feet from the shore of Morris Island. It was then deemed advisable to change the direction, and it is proposed that the outer portion of the south jetty, which will rest upon the crest and the outer slope of the bar, shall be straight and parallel to the seaward portion of the north jetty, and at a distance from the latter of about 2,900 feet. This part of the south jetty will therefore have a bearing of south 58 degrees east; and it was decided to join it to the straight portion already laid by a circular arc struck with a radius of about 1¾ statute miles.

On this arc, or rather on chords of the arc of about 400 feet length, the bottom course of the south jetty was continued through the months of March and April, 1882, when operations were suspended, funds having been exhausted.

A modification in the method of laying the bottom course of the south jetty was introduced January 1, 1882. It was judged that the mattresses would lie better if each one lapped from 10 to 20 feet over the one preceding it. The logs will probably break from the binding-poles and firmly rest on the ground when the riprap stone is thrown upon them. Additional height of the bottom course is obtained thereby, spaces between mats are obviated, and the loss of stone is in great measure prevented. Since the beginning of the year 1882 the mattresses have, therefore, been laid with laps averaging about 12½ feet, in some cases exceeding 20 feet.

Towards the close of the year 1881 it was observed that a strong current set across the jetty near its outer end, and it was apprehended that in extending the work that current would cause scour or under-cutting. To guard against this danger it was decided, in further extending the work, to make every third mat of the foundation course 130 feet wide, the other mats having widths of from 99 to 108 feet. The projecting portion of the wider mat was intended to act as a short spur on either side of the jetty. The width of 130 feet was adopted because it was found that mattresses of greater dimensions were difficult to handle in the strong current and heavy sea which frequently prevailed where work was in progress. Further precautionary measures may have to be taken to counteract the scouring effects of the currents on the site of the jetty. The mats of 130 feet width were first laid during the month of January, 1882, and they were continued until work was suspended, in April. The total length of apron foundation by which the south jetty was extended during the fiscal year was 3,209 feet. The aggregate thickness of the work when laid was from 3 to 7 feet, but at a few places it has settled, and the crest of the apron actually rises above the original surface of the ground from 1 to 7 feet.

On June 30, 1882, the seaward end of the work was 10,122 feet from the shore of Morris Island, measured along the axis of the work, and about 1½ mile within the outer 18-feet curve of the bar. The deep-water pocket, with depths of about 25 feet, east of the main ship-channel, was crossed by the bottom course during the year. The work last placed is now fairly on the inner slope of the bar, in depths of 16 or 17 feet at mean low-water.

The widths of the log and brush mattresses ranged from 99 to 108 feet, with spur mattresses of 130 feet width, as just stated, and the quantity laid amounted to 52,163 square yards, with an average thickness of 18 inches. The aggregate thickness or height of the work, logs, brush, and stone, varied from 3 to 6 feet.

The mats were loaded with 23,030 cubic yards of stone. The aggregate amount of riprap stone deposited on the south jetty from the beginning of operations, in April, 1880, is 38,164 cubic yards, or about 46,000 gross tons, and the quantity of mattress work averaging 18 inches in thickness amounts to 97,894 square yards.

SPUR JETTY ON SULLIVAN'S ISLAND.

The sea-shores of both Sullivan's and Morris islands have been washing away for some time, and it was deemed advisable to provide some means of protection. On my recommendation, the Chief of Engineers, on July 20, 1881, authorized the construction of two spur-jetties on the south beach of Sullivan's Island, and of three or four similar works on the seaward shore of Morris Island, at an aggregate cost of not exceeding $10,000, said sum to be charged to the existing appropriation for improving Charleston Harbor.

None of the jetties have been constructed on Morris Island, and only one on Sullivan's Island. This jetty was built in September, 1881. It is located about 1,800 feet east of Fort Moultrie, and consists of log mattresses, overlaid with broken stone.

The width of the jetty is 30 feet, its length 288 feet. It contains 960 square yards of mattresses and 366.5 cubic yards of riprap stone.

A similar spur-jetty had been laid on the same beach and for the same purpose in December, 1880, under a special appropriation. It is located about 3,100 feet to the eastward of Fort Moultrie. A report of this work is contained in Appendix J 2 of the Annual Report of the Chief of Engineers for 1881.

THE CONDITION OF THE WORK.

Soundings recently taken over the north jetty show that no further settlement of consequence has occurred in Beach Channel between the shore of Sullivan's Island and Drunken Dick Shoal. At some points on that portion of the foundation course laid during the past fiscal year some settling has been noted, amounting to from 12 to 21 inches.

On that portion of the apron of the south jetty laid previous to June 30, 1881, some slight settling has apparently taken place at a few points. In the deep water of the main channel, between the eastern and western 21-foot curves, a gradual accumulation of sand on top of the riprap stone covering the mattresses seems to be in progress. The original aggregate thickness or height of the work, allowing for irregularities in depositing the stone, did not probably exceed here about 4 feet. Recent soundings indicate a thickness or height above the original bottom of from 4 to 9 feet. A similar process of accumulation was also noticed at the sea end of the south jetty. In November, 1881, when work was resumed there, it was difficult to find it, as it was entirely covered with sand.

At some points on the section laid during the past fiscal year settling to the amount of 12 to 20 inches is observed, especially near the outer end. The necessity of pushing this work rapidly forward, giving the base ample width and counteracting the effects of parallel scouring currents by spurs of sufficient length, seems to be obvious.

The original area of the water-way over the site of the north jetty as far as it is built was about 169,000 square feet at low-water and 242,500 square feet at high-water. By the constructing of the jetty these areas have been diminished to 109,400 square feet at low-water and 182,800 square feet at high-water. The original areas have been, consequently, reduced by 35.27 per cent. and 24.62 per cent., respectively.

The original areas of the water-way over the site of the south jetty were 176,600 square feet at low-water, and 227,600 square feet at high-water, which have been reduced to 142,500 square feet, or 80.7 per cent., at low-water, and to 193,500 square feet, or 85 per cent., at high-water.

REMARKS ON THE CONDITION OF THE INNER AND OUTER HARBOR.

The surveys made by Captain Greene towards the close of the last fiscal year have furnished means for comparing the present condition of the harbor of Charleston with its condition some fifteen or twenty years ago.

INNER HARBOR.

The shoal extending from Fort Johnson to Fort Sumter has increased. There are indications that in the course of time the whole space occupied by the shoal will become dry land.

A decided shoaling process is going on in Hog Island Channel, between Hog Island and Shute's Folly Island. Folly Island Channel, just south of Castle Pinckney, is deepening, as well as the main or south channel, between the shoal known as "Middle Ground" and James Island.

None of these changes affect the generally excellent capacities of the inner harbor.

OUTER HARBOR AND BAR.

Some noteworthy changes have been observed during the last fiscal year in the outer harbor and on the bar.

The shoal east of Fort Sumter has extended eastward about 500 feet and southward about 1,000 feet.

The northern end of Morris Island, or Cumming's Point, has been washed off to the extent of about 300 feet.

The shallow space between Morris Island and the main channel has deepened. The high-water line has receded some 500 feet upon the island, in consequence of which the latter is now overflowed during high-tides at some places. The heavy gale of August 27, 1881, when the water stood 3 or 4 feet deep on the parade of Fort Sumter, was the principal cause of these changes. The material carried away from the beach of Morris Island, and eroded from the shallow space between that island and the main channel, is believed to have assisted in extending the shoal at Fort Sumter.

No material change has been observed in the main channel itself abreast of Morris Island.

The shoal between the main channel and swash channel is reported to have diminished in area and increased in depth. The deepening observed south of the eastern end of the south jetty, between June and November, 1881, before any work had been done there, is ascribed to the strong currents that pass around the jetty.

Some distance south of the north jetty, past its seaward end, a marked increase in depth has taken place. The material composing the bar is evidently pushed out as the work advances.

The shoals in the vicinity of the bell-buoy, south of the north jetty, referred to in my annual report for the fiscal year ending June 30, 1881, are being cut away at their upper ends and advanced seaward.

The movement of the sand so far is, however, quite irregular, and renders the swash-channel as yet undesirable for navigation. Captain Greene estimates the general movement of sand, between the north and south jetty, at 300 feet in a seaward direction. The curves of depths have moved seaward to that extent.

While the north jetty will, if funds are provided, soon reach the full length assigned to it, and will only require additional height and

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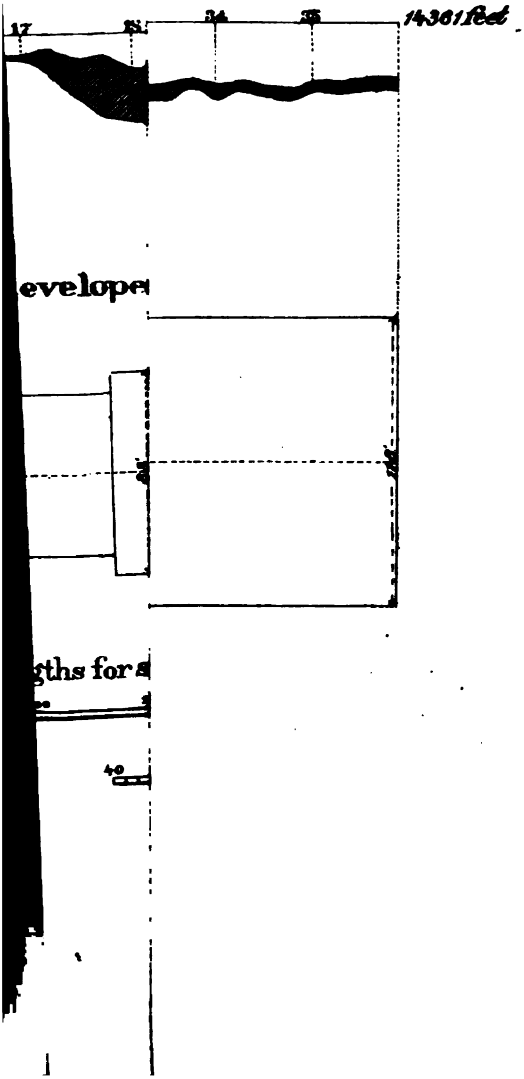


brought to completion with the least possible delay. To this end appropriations of $500,000 at the least are required until the work is done.

There was added to the north jetty during the year a length of 2.319 feet, making a total length of 14,361 feet. This extension is 118 feet wide. This jetty is now nearly out to 18 feet of water, and a further extension of 1,000 feet will bring it to this depth. The south jetty was extended during the year 3,209 feet, of a width varying from 85 to 130 feet, making a total length of 10,121 feet. To reach 18 feet of water this jetty will have to be carried out 8,000 feet. Its present length takes it across all the deep water, and it has now reached the shoal water of the inner slope of the bar.

In December a slight change in the arrangement of the mats was adopted, consisting in lapping them instead of placing them adjacent, or as near as might be. It results that additional height is given as the jetty advances and greater security against scour between the mats.

A short spur jetty was built upon the shore of Sullivan's Island for the protection of the beach and shore-line as an essential feature in the improvement of the harbor and channel.

It is probable that at least one other jetty will be required for this same purpose. At the same time it cannot be said that there is any danger of the entire destruction of this island, or even of Morris Island. More than a hundred years ago it was said, in a description of Charleston Harbor—

"Of Sullivan's Island, which is on the north side of the entrance to Charleston Harbor, the bay on the west side has so encroached (though most defended, it being, on the contrary side to the ocean) that it has gained in three years' time one-quarter of a mile, laying prostrate and swallowing up vast pine and palmetto trees. By such a process, with the assistance of a few hurricanes, it probably, in some few years, may wash away the whole island, which is about 6 miles in circumference."

These apprehensions have not been realized, and such has been the effect of the jetties built for the protection of Fort Moultrie and other parts of the shore, that it is tolerably certain they never will be.

At the same time it must be admitted that a gale of unusual severity and under favorable conditions will always do great damage to the island shore and property in the vicinity.

The advantage gained by the jetties is in accumulating sand which may resist the sea for some hours until the storm has abated.

One of the severest gales ever known upon this coast occurred upon the 27th of August, 1881. In a few hours the high-water line from Fort Moultrie for 1 mile to the east was advanced upon the shore from 100 to 200 yards, and in many places extended entirely across the island. In such times jetties furnished protection only in the way indicated above.

The sand-covering upon Morris Island was partly removed in this gale and the sea breaks across the island in several places at high-tide. It is possible that some simple construction should be resorted to to collect the sand again. This will form the subject of a special report if the necessity becomes imperative.

During the year a map of the inner harbor was completed. The survey from which this map was made was conducted in the most thorough manner, and is satisfactory in several ways.

It furnishes a starting point of comparison from which the changes that may take place in the harbor may be detected. It shows that the principal changes in the last twenty years are the formation and extension of the sand-bar from James Island to Fort Sumter; a shoaling of the Hog Island Channel and deepening of the Folly Island Channel and South Channel, or Main Channel. Aside from these, comparative cross-sections of the harbor show a very considerable increased area of water-way in the South Channel over that indicated in the Coast Survey charts of the harbor. The harbor may, therefore, be said to retain its depth and convenience as the site of a great commercial port. The three changes mentioned above are not in any sense to be regretted, and we may look to the day when the shoal between James Island and Fort Sumter shall be redeemed altogether from the sea, when Hog Island Channel shall be entirely closed, and the Folly Island Channel form the shortest and usual channel for steamships which are bound for the front along Cooper River.

With the extension of the jetties and the attainment of deep water at the entrance to the harbor it will certainly be one of the best in the world.

The general inspection of the map just referred to shows that the apprehensions that have been felt as to the effect of the material thrown into the rivers above the city upon the depth of the harbor are unfounded. Nor do I believe that the time will ever come when any serious injury to the harbor will be felt therefrom.

CHANGES IN THE OUTER HARBOR.

A comparison of the maps made from the surveys of 1881 and 1882 with the Coast Survey chart and with one another shows very considerable changes in the outer harbor and on the bar.

Some of these changes may be attributed to the jetties and others not. Beginning with the shoal at Fort Sumter, we find it to have increased in size and to have extended to the southward about 1,000 feet and to the eastward 500 feet.

Cummings' Point has cut away some 300 feet. The entire area between the main ship-channel and Morris Island has deepened considerably, and the high-water line has advanced across Morris Island in some places; in other words, the sea is gradually encroaching upon Morris Island. The material removed from this island and the area between its shore-line and the 18-foot curves has been carried up the harbor and added to the shoal at Sumter.

This change has been going on for fifteen years, and cannot be attributed to the jetties. The most marked effect was produced by the gale of August, 1881, which advanced the 12-foot curves towards the shore some 500 feet, and advanced the high-water line nearly as much. These facts point to the necessity, at some future day, of several substantial and extensive jetties for the protection of the shore-line of Morris Island.

Most of these jetties will be required to the southward of the south jetty. The main ship-channel remains unchanged in cross-section, although it may be said that there is a slight shoaling on the line of the two black buoys in the northeast course entering the harbor.• The shoal separating the main ship-channel and the entrance to the Swash Channel has diminished somewhat in area. The depth of water upon it has increased. This effect has been produced upon the part north of the south jetty by the extension of the Fort Sumter shoal to the eastward, and the greater change in the portion south of the jetty has been caused by the increased current around the end of the south jetty, as it was left upon the suspension of work June 30, 1881.

Coming now to the deep pocket which forms the entrance to the Swash Channel, we find a very slight change at the upper end. In some places there are indications of shoaling and in others of deepening over small areas.

These changes are slight, however, and are probably due to the action of the north jetty in obstructing the current, and chiefly to the Sumter shoal, which has forced a body of water out towards the Swash Channel, and thus aids the achievement of the results sought in the building of the jetties.

Following this deep pocket down as far as the jetty, we find no great change in its section until we pass the jetty, when there is a marked increase in size, even since last year, and an evident advance of the material lying beyond the end of the jetty, as it was gradually extended.

The western extremity of shoal B has been very considerably cut away and advanced to the seaward. The main body has increased somewhat in depth and shows such changes as to indicate that the sand is moving gradually seaward. Shoal A shews similar indications. Sand has lodged in detached places in the channel, and as a result the swash-channel is more difficult of navigation than last year. This condition of change and deterioration, so plainly indicated by a comparison of the maps this year and last, may be expected to continue another year and until the south jetty is extended.

The general advance of the sand included between the jetties seaward may be said to be about 300 feet during the year, and is plainly marked. It shows that there is nothing between the jetties that the currrent will not move.

During the extension of the south jetty across the deep pocket, the strongest current yet encountered was met with; the bottom is hard and smooth and the depth very uniform.

The funnel-shape of this pocket is the cause of the very strong current, and as soon as it passes the extremity of shoal B it is dissipated over the bar and has produced no extended effect.

The work of examination and survey has been intrusted to Assistant Engineer J. P. Allen, who has done it with energy and intelligence. The supervision of the construction has been directly performed by T. H. Fisher and J. L. Frazer, and has been attended to with fidelity and good judgment.

Very respectfully, your obedient servant,

BENJ. D. GREENE,
Captain of Engineers.

Lieut. Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

J 2.

IMPROVEMENT OF ASHLEY RIVER, SOUTH CAROLINA.

On July 1, 1881, the sum of $2,500 was available for improving Ashley River, South Carolina, being the aggregate of two appropriations made for this work, namely, one of $1,000 made by act approved June 14, 1880, and another of $1,500 made by act approved March 3, 1881. A general description of the locality was given in my Annual Report for the year 1880.

The plan of improvement recommended comprised—

1. The removal of a shoal or bar at a place known as Accabbee, between 7 and 8 miles above Charleston City, where, according to a survey made under my direction in June, 1873, there is but 9 feet of water at mean low-tide, while the channel of approach to it from below is only about 40 feet in width between the 10-foot curves.

2. The removal of a shoal at a point below the Wando Phosphate Works, about 2 miles above Accabbee, where only 6 feet of water was found at low-tide.

It was proposed to lower these shoals by dredging to a depth of from 10 to 11 feet at mean low-water, requiring the removal of about 25,000 cubic yards of material. The cost of the work was estimated at $5,000.

OPERATIONS DURING THE LAST FISCAL YEAR.

On November 25, 1881, proposals were invited for the removal of 10,000 cubic yards, more or less, of material from Ashley River, at the point known as the crossing at the Wando works.

Only one bid was received, which was made by the Charleston Dredging Company. Their terms were accepted and a contract was concluded with that company on January 18, 1882, at the price of 17 cents per cubic yard.

The work was commenced and completed in February, 1882. A channel of about 100 feet width and over 1,000 feet in length was cut through the shoal separating the 11-foot curves at the locality indicated, and to a depth of 11 feet at mean low-tide. A total volume of 13,558 cubic yards of material was removed.

No further operations were carried on, the funds being exhausted, and no work can be done during the fiscal year just commenced, unless further appropriations are made for this improvement.

The sum of $2,500 is required to complete the work of improvement under the existing plan.

The channel near the Wando works, lately excavated, has so far remained in good condition.

It is not at all certain, however, that, after completing the improvement, the channels obtained by dredging through the shoals will preserve the depths thus gained.

Dredging will probably have to be repeated occasionally. To render the improvement permanent will require some jetties or wing-dams placed there to control the currents. It is not deemed necessary now to submit a project and estimate of the cost of works for permanently securing a minimum low-water depth of from 10 to 11 feet at the shallow places in Ashley River.

This improvement directly aids the business of the several phosphate works located above the shoals referred to, and indirectly benefits the commerce of the city of Charleston.

This work is located in the collection district of Charleston, S. C. Charleston is the nearest port of entry.

Amount of duties collected in 1881, $99,052.53.

The report of my assistant, Capt. B. D. Greene, Corps of Engineers, is transmitted herewith.

Money statement.

July 1, 1881, amount available	$2,479 93
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	2,394 86
July 1, 1882, amount available	85 07
Amount (estimated) required for completion of existing project	2,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	2,500 00

Abstract of proposals for dredging in Ashley River, South Carolina, opened December 10, 1881.

No.	Bidder	Price per cubic yard.	To commence—	To complete—
1	Charleston Dredging Company	$0 17	On or before January 15, 1882	In 30 days.

Abstract of contract for dredging in Ashley River, South Carolina.

Contractor.	Date of contract.	Price per cubic yard.	To commence—	To complete—
Charleston Dredging Company	Jan. 18, 1882	$0 17	Feb. 1, 1882	March 15, 1882.

REPORT OF CAPT. B. D. GREENE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., July 1, 1882.

COLONEL: I have the honor to submit the following report upon the improvement of Ashley River, South Carolina, for the fiscal year ending June 30, 1882.

Dredging was begun upon the Ashley River at the Wando Crossing under contract with the Charleston Dredging Company on the 1st of February, and was completed during the month.

A channel of 100 feet in width and 12 feet in depth at low-water was opened through the bar, and has so far remained in good condition.

It cannot be expected, however, that it will always remain so, unless some jetties or dams are placed there to control the current.

Very respectfully, your obedient servant,

BENJ. D. GREENE,
Captain of Engineers.

Lieut. Col. Q. A. GILLMORE,
Corps of Engineers.

J 3.

IMPROVEMENT OF WAPPOO CUT, SOUTH CAROLINA.

By the river and harbor act approved March 3, 1881, the sum of $10,000 was appropriated for improving Wappoo Cut, South Carolina. This was the first appropriation ever made by Congress for this work.

Wappoo Cut is a narrow, tortuous, tidal creek, to the north of James Island, South Carolina, connecting Stono and Ashley rivers. An examination with a view to its improvement was made in October, 1880, in compliance with section 2 of the act approved June 14, 1880. My report on this examination was submitted to the Chief of Engineers with my latter dated November 22, 1880.

The project of improvement recommended contemplated the establishment of a straighter channel of 6 feet depth and 90 feet width at mean low-water, at an estimated cost of $34,000.

The work has not yet been commenced.

In a letter to the Chief of Engineers, dated April 19, 1881, it was stated that if it was thought desirable to expend the sum of $10,000 appropriated by act of March 3, 1881, during the fiscal year beginning on July 1, 1881, work should be commenced at the Stono end of Wappoo Cut by contract or by hiring a dredge, as might seem best. It was suggested, however, that so little could be accomplished with the money appropriated, and the work done would be so wanting in permanency of character, that it might be best to wait until another appropriation was made.

By department letter, dated May 27, 1881, authority was given to defer the execution of the project of improvement until it could be ascertained, by a further examination, whether or not better results may be obtained by postponing operations until another appropriation was made.

In March, 1882, an opportunity seemed to offer for expending the amount of money on hand in dredging at the shoalest places of Wappoo Cut, between Stono River and the large bend, situated about midway between Ashley and Stono rivers.

Under date of March 21, 1882, proposals were invited for the removal of 50,000 cubic yards, more or less, of material from Elliot's Cut, and that portion next thereto, for a distance of half a mile.

Only one bid, an informal one, was received under this call. It was made by the Charleston Dredging Company. Their offer was not accepted, as the price named for doing the work was deemed too high, and the date of completing it too uncertain and remote.

It was considered that an additional appropriation would soon be made, which, with the sum of $10,000 already available, would be sufficient inducement to competing bidders, and more favorable terms could probably be obtained.

OPERATIONS CONTEMPLATED DURING THE PRESENT FISCAL YEAR.

With the sum of $10,000 available July 1, 1882, and any additional amount that may be appropriated, it is proposed to improve the bar at the entrance of Wappoo Cut into Ashley River by dredging and by building a jetty; to dredge in Elliot's Cut and in the reach leading to it, and on the bar at the outlet into Stono River; and possibly, if the funds on hand should permit, to construct a jetty at the Stono entrance. The work will be done by contract, or, if this should be found to be impracticable, by hiring a dredge and labor and buying the material required for the jetties in open market.

As stated in my report of the examination for the improvement of Wappoo Cut, dated November 22, 1880, this cut is of considerable importance as a commercial route. In 1879 the aggregate value of freight of all kinds passing through, amounted to nearly $3,000,000.

The bulk of it consisted of sea-island cotton, rice, and phosphate fertilizers. It is stated that this trade is annually increasing, and that it would be still more rapidly developed by a suitable improvement of the passage.

This work is located in the collection district of Charleston, S. C. Charleston is the nearest port of entry.

Amount of duties collected on imports in 1881, $99,952.53.

Money statement.

July 1, 1881, amount available	$10,000 00
July 1, 1882, amount available	10,000 00
Amount appropriated by act passed August 2, 1882	10,000 00
Amount available for fiscal year ending June 30, 1883	20,000 00
Amount (estimated) required for completion of existing project	14,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	14,000 00

J 4.

IMPROVEMENT OF SAVANNAH HARBOR AND RIVER, GEORGIA.

During the fiscal year ending June 30, 1882, the operations for improving Savannah Harbor and River were carried on in conformity to the plan submitted August 28, 1873, and the supplementary project of March 19, 1879, but the operations also included some works executed in the vicinity of Fig Island, specially authorized by the Chief of Engineers, and forming a part of the enlarged project for permanently improving Savannah Harbor and River submitted with my report of an examination of the river dated January 16, 1882.

This examination had been made in accordance with section 3 of the river and harbor act approved March 3, 1881, which provided that an examination or survey, or both, with estimates of cost of improvements proper, should be made in the Savannah River and Harbor, to increase the depth of the water in said river and harbor from the bar up to the city to 22 feet, and to make an estimate of the cost of widening the channel of the Savannah River opposite the city to 600 feet, of uniform depth with the balance of the channel.

During the two years preceding the autumn of 1873, Congress had appropriated the sum of $100,000 for improving the river below the city of Savannah, which was expended mainly in removing wrecks, cribs, and other obstructions.

By act approved February 27, 1874, the sum of $193,132.96 was appropriated for the relief of Mr. Henry S. Wells for work done by him under contracts with the Treasury Department of May 1 and July 5, 1866. This work comprised the removal from the Savannah River of 20 vessels, 40 cribs, 150 piles, many iron-shod snags, and a number of torpedoes.

PLAN OF IMPROVEMENT.

1. *By the original plan of improvement, submitted August* 28, 1873, it was designed to provide for an improved channel from Tybee Roads to the city of Savannah, navigable at high-tide for vessels drawing 22 feet of water, where previously the navigable high-water depth rarely exceeded 16 feet.

The bulk of the work contemplated in this project consisted in widening the water-way at the city front, and in deepening, widening, and straightening the channel by dredging at various points below the city to near Tybee Roads. The plan also provided for a dam at the cross-tides 4 miles above the city of Savannah; and, further, for a short bulkhead on the Hutchinson's Island side just above Kinsey's Mill.

The cost of these works was estimated at $481,320.

The permanency of the improved channel to be obtained by the means proposed was not considered assured, and the eventual necessity of additional works was anticipated.

2. *The supplementary plan of improvement of March* 19, 1879, had for its main object the improvement of the north channel of the Savannah River in preference to the south channel, from the head of Elba Island to the head of Long Island. The new features introduced in this design consisted in the construction of a low dam across the upper end of the south channel, in closing by dams the lateral channels then connecting the north and south channels from Elba Island to Cockspur Island, and in providing for shore protection where needed. It was proposed, also, to enlarge the ship-channel by dredging to a minimum low-water depth of 14½ or 15 feet and a width of 125 feet on all shoals between the city and Tybee Roads, a design which essentially was embraced in the former project.

This supplementary or modified project practically superseded the original plan, but it was admitted that other works would be needed, chiefly for the reason that the river is excessively wide at various places below the city, and must be contracted by suitable works to secure the preservation of the deepened channel. No estimates of the cost of works for contracting the channel were given however.

It was estimated that the aggregate cost of the works embraced in the supplementary or modified project would come within the estimate accompanying the original project of August 28, 1873, or at most would not increase the cost of the improvement more than a few hundred dollars.

3. *The enlarged plan of improvement embraced in my report of January* 16, 1882, retains the leading features of the two preceding projects. A number of works are also provided for that are judged to be necessary for the further improvement of the channel of navigation from Tybee Roads to the city of Savannah, and to render said improvement practically permanent.

Cross-Tides.—The project anticipates the eventual necessity of raising the dam at Cross-Tides on its whole length to the level of ordinary high-water.

Improvement of the water-way between Cross-Tides and the city of Savannah.—More or less dredging is to be done in the reach of Front River from Cross-Tides to the city, in order to give increased facilities to the entrance of the tidal wave.

Improving the water-way opposite the city front, and at Fig Island.—A strip of land will be cut away from Hutchinson's Island, opposite the city, if the damages are not placed too high, in order to widen the river here to 600 feet, gradually increasing the width to 650 feet or more near Fig Island; and a considerable amount of material will be removed by dredging along the city front on nearly the whole width of the river. This is expected to give a low-water depth of 22 feet on the city side of the river, so that vessels can load to their full draught and move from wharf to wharf at any stage of tide without grounding, while the rest of the channel will have a depth of only 22 feet at high-water.

These operations were, to a more limited extent, included in the previous plans, but the present project provides not only for greater widths and depths, but also for the purchase of the land that must be cut off from Hutchinson's Island; and, moreover, for the construction of 3 wing-dams near Garden Bank Shoal, where the river is much too wide. The heads of these dams will fix the position of the proposed bulkhead line in that locality opposite the city.

New channel at "The Wrecks."—Observations have shown it to be necessary to confine or concentrate the currents issuing from Front River during the latter stages of the ebb-tide to preserve the depths gained by dredging in the new channel at "The Wrecks." The new project, therefore, contemplated the construction of a training-wall or jetty extending eastward from the lower end of Fig Island.

Improvement of the water-way from the vicinity of Fort Jackson to the head of the North Channel.—To improve the water-way from Fort Jackson to the head of the North Channel, it is proposed to close by dams the arms of the river passing on either side of Barnwell Island, and to construct wing-dams opposite the head of Elba Island, at the "Obstructions," to regulate the width of the channel of navigation and maintain the requisite depths to be obtained by dredging.

Dam at the head of South Channel.—The dam at the head of the South Channel that formed part of the plan of March 19, 1879, and which is partially constructed, will be raised higher, reducing the average low-water depth over its crest to 5 feet or less, but leaving a gap for a width of 200 feet at least 10 feet below ordinary low-water line for the accommodation of vessels of moderate draught bound in or out of Saint Augustine Creek, which forms part of the inland passage to Florida.

Improvement of the water-way of the North Channel from the head of Elba Island to the lower end of Jones Island.—The several wide and shallow reaches existing in this section of the Savannah River are to be narrowed and improved by spur-jetties and training-walls, and, if necessary, by light intermediate traverses. The project contemplates the construction of eight spur-jetties on the north side of the channel and of six on the south side; but these numbers are not regarded as fixed, nor can the final dimensions to be given to these works be determined in advance, since observations to be made during the progress of the operations may suggest various changes. To expedite the formation of sufficient depths between the heads of the opposite jetties, and above and below, more or less dredging will doubtless be required.

Closing all the cross-channels between the islands from Elba Island to Cockspur Island.—The dams required for closing the lateral channels connecting the North and South Channels formed part of the supplementary project of March 19, 1879, but it had not been determined at that time to raise them to a greater height than about the level of low-water.

In my annual report for the fiscal year ending June 30, 1881, it was stated that it had been decided to build these dams up to high-water level, in consequence of which the total estimate of $481,869.64 for works thus far approved would probably be exceeded by from $25,000 to $30,000.

Improvement of Savannah River from the lower end of Jones Island to Tybee Roads.—Experience had shown that dredging operations alone for the purpose of establishing an improved ship-channel through the shoal northeast of Fort Pulaski and the Oyster-Bed or Red-Light Shoal were not sufficient to maintain a suitable passage, and that other means were needed permanently to compel a larger volume of water to flow through the channel. Its eastern continuation from the "Knoll" to Tybee Roads, known as Saint Michael's Channel, was also found to be shoaling from sand driven in on the north side by the currents from Calibogue Sound and by breaking waves of northeasterly gales.

To improve the mouth of the river at this locality, it is designed to run a jetty or training-wall from some point on either Jones or Turtle Island in an easterly or southeasterly direction to Red-Light Beacon, and to protect Saint Michael's Channel on the north side by a similar work. One or two spur-jetties from Cockspur Island for concentrating currents on the shoal south of Red-Light Beacon, were also suggested.

Shore protections.—Works of this kind were contemplated and estimated for in the project of March 19, 1879, and form also a part of the enlarged project.

Dredging.—Dredging will be done at the places above indicated, and elsewhere if needed. It is proposed to carry on this class of operations in conjunction, as far as practicable, with the construction of works designed to concentrate the currents of the river at these places.

The foregoing remarks give a condensed description of the enlarged project for permanently improving Savannah River and Harbor, submitted with my report of January 16, 1882.

The total cost of the enlarged project is estimated at $730,000 in addition to the sum of $482,000, which is the aggregate of appropriations made for this improvement from the beginning of work in 1874 to 1881, inclusive.

It was recommended in the report to carry on the operations generally by hiring labor and buying material in open market. This was considered preferable to having the work done by contract, since government now owns a suitable plant, and because by the first method changes in the mode of construction can freely be made when it may be deemed advisable. The only exception may be dredging, which possibly will be done by contract.

In this enlarged project, the general method of completing the improvement is briefly described for the principal portions of the river that are to be improved; but in carrying out the new plan the number and extent of works actually constructed may differ more or less from what is indicated in the report and project. It is believed, however, that the permanent improvement of the river can substantially be accomplished with the expenditure of the sum named, if the annual appropriations for carrying on the work are made on a liberal scale.

Brief recapitulation of work done for improving Savannah River and Harbor since the original project of August 28, 1873, *was adopted, and prior to July* 1, 1881.—At Cross-Tides a submerged dam was constructed formed of brush mattresses and a superstructure of riprap stone. The crest of the work was raised, generally to the level of low-water, but at some places it was from 6 to 8 feet below that line.

About 70 feet in length of the old King's Island jetty was removed to increase the flow of water in Front River.

Between King's and Hutchinson's islands, and lower down in Front River to the city of Savannah, about 96,500 cubic yards of material were removed by dredging.

Dredging to the amount of 218,400 cubic yards was done in Front River, to increase the depth of water on Garden Bank Shoal and to widen the river by cutting off the projecting point of Fig Island, opposite the wharves of the Savannah, Florida and Western Railroad.

The original project contemplated the improvement of the old or Fig Island Channel, and about 142,600 cubic yards of material were excavated there in 1874 and 1875. It was found that this circuitous passage would constantly fill up again, and in a letter to the Chief of Engineers, dated May 13, 1875, I recommended that this line be abandoned and a straighter course adopted, near and about parallel to the south bank of the river. This plan was approved and the new passage opened, known as the new channel, at "The Wrecks." About 430,000 cubic yards of material were removed from this channel in the years from 1876 to 1881.

More or less dredging was done at the "Obstructions," head of Elba Island, and lower down as far as Tybee Knoll, aggregating about 354,000 cubic yards.

By far the larger portion of the dredging at the several points indicated had to be done to satisfy the immediate wants of commerce and navigation.

A number of wrecks of large vessels and portions of wrecks as well as piles, cribs, and other obstructions were removed from the ship-channel.

A submerged dam was built across South Channel, near its up perend. This work formed a part of the supplementary project of March 19, 1879.

During the period named the aggregate sum of $482,000 was appropriated for this improvement, of which the sum of $1,000 is to be applied to payment of damages for land taken on Fig Island for widening the channel.

The expenditures to June 30, 1881, amounted to $311,528.22, including some outstanding liabilities.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1882.

Cross-Tides Dam.—As stated in my last annual report, the crest of the dam reached at several places up to the level of low-water, but in the deep-water channel near Argyle Island there was still from 6 to 8 feet of water over it at low-tide. As very strong currents passed over this portion, threatening the banks and rice-fields on the north side of the river, it was raised higher by depositing several hundred cubic yards of stone thereon.

It became apparent during the latter part of the fiscal year that the crest of the work should be raised still higher, or some feet above the low-water line, by means of mattresses and riprap stone. My recommendation to that effect was approved by the Chief of Engineers May 10, 1882.

Mattresses could be used only to a limited extent owing to the strong currents. Two hundred and eighty square yards of brush mats, 12 inches thick, were placed in the dam and 333 square yards of log mats upon the adjoining shore for protecting it from scour. To hold these mats in place 124 cubic yards of stone were employed.

For raising the superstructure of the dam to the height of 3 feet above low-water 2,514 cubic yards of stone were deposited, making a total placed on this work during the fiscal year of 2,638 cubic yards.

Improving the water-way opposite the city front and at Fig Island.—The most important work done here during the last fiscal year consisted in the construction of two wing-dams, intended to produce stronger currents by reducing the width of the water-way at Garden Bank Shoal. The construction of these works, which form a part of the enlarged project of January 16, 1882, was authorized by letter of the Chief of Engineers of the same date.

The shore ends of both dams rest on Fig Island.

The upper dam or Dam No. 1 is located 400 yards below Clarke & Willink's dry dock, and about opposite to the mouth of Lamar's Canal. Its length is about 300 feet. Dam No. 2 was placed about 250 yards below No. 1. Its length is nearly 350 feet.

These wing-dams were substantially constructed and were formed each of five courses of heavy log mattresses ballasted with riprap stone, with a number of piles driven alongside to assist in keeping them in place.

The bottom course of mats was 30 feet wide; the width of the other courses was 15 feet. They were completed to the level of high-water in March last.

The width of the water-way at and near the sites of the dams was formerly from 900 to 1,050 feet. It is now reduced to about 660.

The snag-boat Toccoa, recently constructed for use on the Savannah River below Augusta, was employed for some time in removing old piles obstructing operations in building the wing-dams.

Dredging operations were carried on in this part of the river, for the purpose of increasing the width of the water-way at the projecting point of Fig Island to not less than 660 feet, and of obtaining greater depths on Garden Bank Shoal and vicinity, which are expected to be maintained by the action of the wing-dams just described, and by the improved flow of water in Front River generally. An aggregate of 24,289 cubic yards of material was here removed during the past fiscal year, 5,925 cubic yards having been taken out under the contract with the American Dredging Company, which was closed in October, 1881, and the balance under the new contract with Dickerson and Paulson.

Negotiations are still in progress for an appraisement and transfer to the United States of land on Hutchinson's Island, that must be cut off to widen the river to 600 feet opposite the upper part of the city, gradually increasing the width to 650 feet or more near Fig Island. This matter has been pending about eighteen months.

The new channel at "The Wrecks."—In a letter to the Chief of Engineers, dated November 2, 1881, I stated that the construction of a deflecting jetty at Fig Island, referred to in some former reports, had become necessary to maintain the depths obtained by dredging in the new channel at "The Wrecks," and recommended that the work be done under authority granted in department letter of June 16, 1881, which provided that certain dams lower down should be built by hired labor and purchase of material in open market. The construction of this jetty was approved on November 4, 1881.

Work was begun in December following, and completed, so far as deemed necessary at present, in March, 1882.

The main line of the jetty starts from near a point a little above the extreme eastern end of Fig Island, with which it is connected by a spur or return face of about 160 feet length. The direction of the jetty is about due east, and its total length 5,000 feet. Its crest generally rises 3 feet above the level of low-water. At its upper end its axis is 800 feet from the proposed bulkhead line of the south bank; this distance gradually increases toward the lower end of the work, where it is about 880 feet. The south shore bulkhead line will be from 10 to 80 feet in advance of the present shore line.

The greater part of the jetty is located in shallow water, and for a length of nearly 2,000 feet it rests on a shoal dry at low-tide. Its lower end is now in 6 feet of water, but it will be extended into greater depths if necessary.

The jetty is composed of log and brush mattresses covered with riprap stone. One, two, and three courses of mattresses were used, depending on the depth of water where they were sunk. The width of the first or bottom course ranged from 20 to 40 feet; the other courses were 15 feet wide. At the head the base of the work for a length of 66 feet is enlarged to a width of 90 feet.

The dredging done in the new channel at "The Wrecks" during the past fiscal year amounted to 37,153 cubic yards, of which 33,093 cubic yards were taken out by the United States dredge steamer Henry Burden, and the rest by contract work.

Closing dams between islands from Elba Island to Long Island.—The work of closing the side channels, from Elba Island to Long Island, was accomplished in the months of March, April, and May, 1882.

As stated in my annual report for the fiscal year ending June 30, 1880, it had originally been intended to construct these dams of timber cribs resting upon an apron composed of a log and brush mattress. Above low-water line a continuous timber superstructure was to rest on the cribs. The apron, outside of the cribs, was to be ballasted with riprap stone, and cribs and superstructure were to be filled with brush and riprap stone or clay from the adjacent banks.

In view of the recent successful application of log mattresses in combination with stone at several places and for similar works, and considering the scarcity of the skilled labor required in the construction of cribs, and the possibility of more rapid execution, I recommended in a letter to the Chief of Engineers, dated September 7, 1881, that the cribs and timber superstructure be omitted, and layers or courses of log mattresses substituted therefor. Each course was to be weighted with riprap stone, and brush might be added for close packing. The apron or foundation course was to be retained, and was to project some distance beyond the upper courses on each side. The superstructure reaching up to the level of high-water to consist of riprap stone, with a hearting of logs suitably connected with the course below.

This modification was approved by department letter dated September 13, 1881.

Under authority granted June 16, 1881, the work was to be executed by means of hired labor and purchase of material in open market. An arrangement was made with Mr. Myron Bangs, of Fayetteville, N. Y., to supply the necessary material at the price of 65 cents per square yard of log mattresses, 75 cents per cubic yard of brush in compact bundles placed on the mattresses as might be directed, and $3.50 per cubic yard of stone piled on barges. At the same rates Mr. Bangs also furnished the material for the other dams already mentioned.

Three side channels were closed. One of the dams, 290 feet long, now shuts off Philbrick's Cut, between the lower end of Elba Island and Island 1 and 2; another dam, 2,477 feet long, runs across the channel between Island 1 and 2 and the head of Bird Island; and a third dam, 482 feet long, closes the channel between Bird and Long Island. All these works were constructed substantially in accordance with the modified plan, and were finished up to the level of high-water.

Mouth of river.—The operations consisted in dredging in the channel at Oyster Bed Shoal, northwest of Fort Pulaski, and in the channel at Tybee Knoll, northeast of the fort, and in its easterly continuation, called Saint Michael's Channel. On the latter section the United States dredge steamer Henry Burden removed 33,047 cubic yards of material.

Near Oyster Bed Shoal the American Dredging Company, of Philadelphia, removed by dredging 19,212 cubic yards. Under a special arrangement their dredge was employed for some days in removing portions of wrecks obstructing the same channel, for which work the company also supplied a quantity of explosives.

Material used.—The material employed in constructing the several dams during the past fiscal year amounted, in the aggregate, to 68,545 square yards of log mattresses, 9,036 cubic yards of brush on mats, and 9,947 cubic yards of riprap stone.

Condition and effects of the works.—All the dams thus far constructed, including that at Cross Tides, seem to stand well, and show no signs of settling.

The two wing-dams built from Fig Island, and the training wall extending eastward from the lower end of that island, are reported as already producing favorable effects upon the obstructions to navigation which they are designed to remove. These works are of recent construction, and it is not doubted that their beneficial action will be still more developed during the fiscal year just begun. Similar remarks also apply to the dams closing the side channels below Elba Island, which were built in March, April, and May, 1882.

OPERATIONS CONTEMPLATED DURING THE PRESENT FISCAL YEAR.

During the fiscal year beginning July 1, 1882, operations will be carried on by means of the balance on hand on that day, amounting to $15,051.92, and such additional appropriation as may be made by Congress.

It is proposed and recommended that the work of improvement be prosecuted in conformity to the enlarged project submitted with my report of January 16, 1882. The number and extent of works that may be constructed will depend on the amount of funds that will be available, taking also into consideration the question whether any payment for land damages shall have to be made out of these funds. The order in which the works are to be executed should be determined by the condition of the river and the observed effects of the works already constructed, at the time when active operations can be resumed. This seems to be the most suitable plan, as it is proposed to suspend operations until the end of October next, the river being reported to be injurious to the health of persons employed in rafting timber upon it during the warm season, and work cannot, during that time, be advantageously carried on.

Concerning the question of the amount of commerce and navigation that may be benefited by completing the improvement, I beg leave to refer to the letter received by me from Hon. J. F. Wheaton, mayor of the city of Savannah, a copy of which is herewith transmitted, and also to the remarks made by me in my last annual report, printed as Appendix J 5 of the Annual Report of the Chief of Engineers for 1881.

The sheltered situation of the harbor of Savannah, its connection by river with the upper portions of the States of Georgia and South Carolina, and by rail with extensive cotton districts and with the grain-growing States of the Mississippi Valley, render the port attractive and valuable, and it cannot fail to acquire still greater importance when the channel of approach from the sea to the city wharves shall have been permanently improved.

This work is located in the collection district of Savannah. Savannah is the nearest port of entry.

The amount of revenue (duties on imports, tonnage dues, &c.) collected during the year from January 1, 1881, to December 31, 1881, was $393,265.84.

Since the works of improvement were commenced the following appropriations have been made:

By act of Congress approved June 23, 1874	$50,000
By act of Congress approved March 3, 1875	70,000
By act of Congress approved August 14, 1876	62,000
By act of Congress approved June 18, 1878	70,000
By act of Congress approved March 3, 1879	100,000
By act of Congress approved June 14, 1880	65,000
By act of Congress approved March 3, 1881	65,000
	482,000

Of this amount there has been expended up to the close of the year ending June 30, 1882, including outstanding liabilities, the s $466,948.08.

To complete the work of improving Savannah Harbor and Ri accordance with the enlarged project of January 16, 1882, furth propriations are required to the aggregate amount of $730,000, makes the total estimated cost of the work of improvement equ $1,212,000.

The following drawings and papers accompany this report:

Sheet 1.—Sketch of Garden Bank Shoal, showing sites of wing-dams now buil soundings taken in December, 1881.

Sheet 2.—Sketch of the new channel at the "Wrecks," soundings taken in D ber, 1881.

Sheet 3.—Sketch of new channel at the "Wrecks," showing location of jett cently built, and soundings taken in June, 1882.

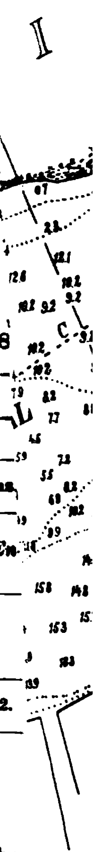
Sheet 4.—Sketch showing spur-jetties at Tybee Island, Georgia.

Report of Capt. B. D. Greene, Corps of Engineers.

Letter of the mayor of Savannah, with statement of chief articles of export.

Money statement.

July 1, 1881, amount available		$170, 47
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$141, 297 27	
July 1, 1882, outstanding liabilities	14, 122 59	
		155, 419
July 1, 1882, amount available		15, 051
Amount appropriated by act passed August 2, 1882		200, 000
Amount available for fiscal year ending June 30, 1883		215, 051
Amount (estimated) required for completion of existing project		530, 000
Amount that can be profitably expended in fiscal year ending June 30, 1884		530, 000



Abstract of proposals for dredging in the Savannah River, Georgia, opened May 25, 188

No.	Bidders.	Price per cubic y'd.	To commence—	To complete—
1	Dickerson & Paulson, Savannah, Ga	$0.15	On award of contract.	Within 3½ months

Abstract of contract entered into June 2, 1882, by Lieut. Col. Q. A. Gillmore, Corps of Engineers, for improving Savannah River and Harbor, Georgia.

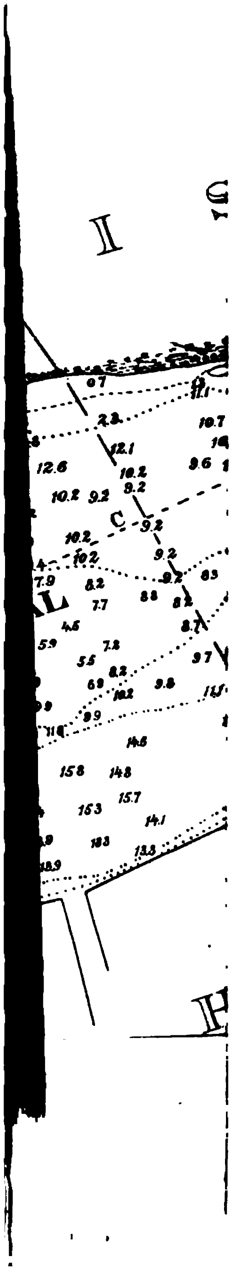
Contractors.	Nature of work.	Price per cubic y'd.	To be completed—
Dickerson & Paulson	Dredging.	$0.15	On or before October 1, 1882.

REPORT OF CAPT. B. D. GREENE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., July 3, 1882.

COLONEL: I have the honor to submit the following report of the progress of the work of improvement of Savannah Harbor during the year ending June 30, 1882.

At the beginning of the year the American Dredging Company were engaged in widening the river below the city under a contract. Beyond this, owing to the failure of several contractors, no work was going on.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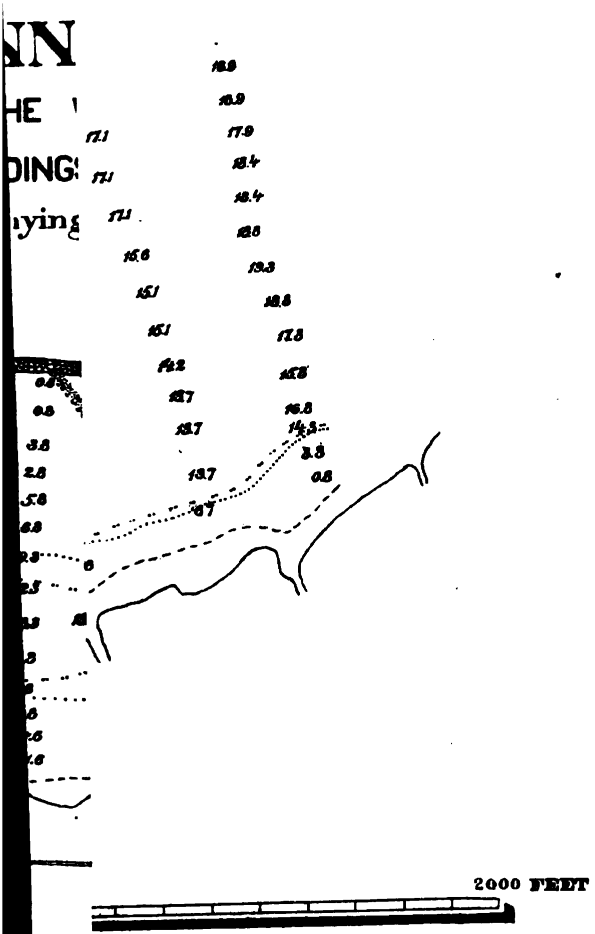
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Sketch showing location of
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In view of the difficulties that seem to attend the prosecution of this work under contract, it was decided to work this year with hired labor and buy the materials in open market. During the summer and early fall a plant was got together and work was commenced in November and has gone on continuously through the year.

In the latter part of August this coast was visited by one of the severest storms ever experienced. Considerable damage was inflicted upon all property along the water front, but no very serious injury was done to anything pertaining to this work, and the necessary repairs were made upon the steamboats and barges during September and October.

The following work has been accomplished during the year:

Cross-Tides dam raised to a height of 3 feet above low-water.

Training-wall constructed along The Wrecks Channel 5,000 feet in length, and to a height of 3 feet above low-water.

Two wing-dams built from Fig Island, to remove the Garden Bank Shoal.

Closing dam between north and south channels known as Philbrick's Cut.

Closing dam between Islands No. 1 and 2 and Bird Island, known as Big Gap. This dam is 2,600 feet long and in places 16 feet high.

Two closing dams between islands below Bird Island. These closing dams are built to high-water mark. Altogether they have stood well. Some settlement will be experienced during the coming year, no doubt, and in the fall probably some rock will be needed on all the dams.

The wing-dams and The Wrecks Channel training-wall are having a very favorable effect upon the obstructions they are designed to benefit.

In both these cases, however, recent surveys indicate the necessity of following with other dams in the vicinity. Comparative maps of the Garden Bank Shoal and the new Wrecks Channel, before and three months after the construction of the dams and training-wall, are forwarded herewith. They show a very decided improvement in both cases.

To hasten the removal of the Garden Bank Shoal a dredge has been at work there during the past month and has taken out 18,364 yards.

The dredge Henry Burden has been at work during the year, as follows:

	Cubic yards.
Four months in Saint Michael's Channel	21,832
Five months in Wrecks Channel	42,250
One month in Knoll Channel	2,058
Total removed by Henry Burden	66,140

R. S. Burnett, assistant engineer in immediate charge of the work, is entitled to credit for the energy and intelligence he has given to the work; and its success is due in no small degree to his efforts.

Very respectfully, your obedient servant,

BENJ. D. GREENE,
Captain of Engineers.

Lieut. Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

LETTER FROM THE MAYOR OF SAVANNAH, GEORGIA.

CITY OF SAVANNAH, MAYOR'S OFFICE, *June* 24, 1882.

DEAR SIR: Your favor of the 14th instant was received in due time. I return the inclosure it contained herein with the blanks filled as requested. It will be observed that the exports of cotton and rice are less for the years 1881 and 1882 than they were for the previous years 1880 and 1881. The deficiency in cotton is accounted for by the short crop generally in the cotton-producing country. While the receipts at this port show a falling off of 15 per cent. compared with last year, the total receipts at all the ports have fallen off 20 per cent., which gives Savannah over an average of the last crop. The falling off in the receipts and exports of rice is due to the partial destruction of that crop by the hurricane that occurred on the 27th of August last, which destroyed fully 30 per cent. of the crop. In all other products the exports are larger than for any previous year, and I am pleased to say that the prospects for the future trade and commerce of this port are decidedly encouraging. The estimates are all based on the various commodities to this date, and can be relied upon as being substantially correct. It is gratifying to note that the Ocean Steamship Company of this city are now having built three new steamships of 3,000 tons each, which will be completed in time for the fall trade.

The work done during the past year under your direction for the improvement of the river has been eminently successful, and has resulted in a decided increase in the depth of water.

Very respectfully, yours,

JOHN F. WHEATON, *Mayor.*

General Q. A. GILLMORE.

J 4.

SURVEY FOR INCREASING DEPTH OF WATER IN SAVANNAH RIVER AND HARBOR TO TWENTY-TWO FEET, AND FOR WIDENING CHANNEL OPPOSITE SAVANNAH, WITH ESTIMATE OF COST.

UNITED STATES ENGINEER OFFICE,
New York, January 16, 1882.

GENERAL: Section 3 of the river and harbor act, approved March 3, 1881, provides that an examination or survey, or both, with estimates of cost of improvements proper, should be made in the Savannah River and Harbor to increase the depth of the water in said river and harbor from the bar up to the city to 22 feet, and to make an estimate of the cost of widening the channel of the Savannah River, opposite the city, to 600 feet, of uniform depth with the balance of the channel.

This work was assigned to my charge by department letter dated March 21, 1881, and I have the honor to submit the following report thereon:

Such examinations as were considered to be sufficient for the purpose in view were, under my direction, made by my assistant, Capt. B. D. Greene, Corps of Engineers, and Mr. S. L. Fremont, assistant engineer.

During the last year operations for improving Savannah River and Harbor were carried on in conformity to the general plan submitted August 28, 1873, and to the supplementary project of March 19, 1879.

The leading object was to establish a navigable channel from Tybee Roads to the city of Savannah, practicable at high-tide for vessels drawing 22 feet of water.

The original plan embraced the construction of a submerged dam at the Cross-Tides, widening the water-way at the city front, and deepening, widening, and straightening the channel by dredging at various points below the city. The cost of these works was estimated at $481,320.

The supplementary project of March 19, 1879, had for its main object the improvement of the north channel in preference to the south channel, from the head of Elba Island to the head of Long Island. The new features introduced in this design consisted in the construction of a low dam across the upper end of the south channel, in closing by dams the lateral channels now connecting the north and south channels, from Elba Island to Cockspur Island, and in providing for shore protection at some points. It was proposed, also, to enlarge the ship channel by dredging to a minimum depth of 14½ or 15 feet, and a width of 125 feet at mean low-water, on all shoals between the city and Tybee Roads, a design which essentially was embraced in the former project.

In both projects it was indicated that other works would be needed, chiefly for the reason that the river is excessively wide at various places below the city, and must be contracted by suitable works to secure the preservation of the deepened channel, but no estimates for works of channel contraction were submitted.

In the present report it is proposed to point out the places where the water-way should be contracted; the works to be constructed for that purpose and other operations to be carried out in order to secure the end in view and not embraced in previous projects, with an estimate of their probable cost. Separate reports of the examination, with general estimates of cost, have been received by me from Captain Greene and Mr. Fremont, and will first be referred to.

Captain Greene is of the opinion that to secure and maintain a deep channel down to Tybee Roads will require the contraction of the waterway the entire distance by means of wing-dams and training-walls suitably distributed. His plan is essentially as follows: The width of the river between the limiting lines marked by the heads of the confining works should be gradually increased from the city of Savannah downwards. At the lower part of the city it would be 650 feet; below the head of Elba Island from 1,000 to 1,200 feet; near Tybee Roads from 1,500 to 2,000 feet.

Captain Greene assumes that the desired end consists in securing and preserving a mean low-water depth of 17 feet in the navigable channel from Tybee Roads to the city. The following works, or sets of works, he thinks, should be constructed for the purpose in addition to those already sanctioned:

1. Raising the dam at Cross-Tides 4 or 6 feet above the level of low-water.

2. A training wall at the eastern end of Hutchinson's Island, extending eastward about a mile, with three spurs projecting from its north side and three from its south side, the heads of the latter to define the north edge of the new channel at "The Wrecks." Aggregate length about 9,300 feet, of which 4,300 feet is for spurs.

3. A system of wing-dams, eight in number, to contract the channel and define its northern margin from the lower end of Back River to near the head of Elba Island; with a closure dam on either side of Barnwell Island, giving an aggregate length of works of about 7,400 feet, of which a length of 6,200 feet would be occupied by spurs.

4. A dam closing channel between Elba and Spirit Island. Length about 700 feet. The channel is also named Duck Puddle.

5. A system of wing-dams defining the northern and southern limits of the ship-channel from the head of Elba Island to the lower end of Long Island. The set embraces six spurs on the north side and seven on the south side of an approximate aggregate length of 16,900 feet.

6. A system of training walls and spurs from Cockspur Island to Tybee Roads. The principal features are a long spur-jetty extending south from Turtle Island towards Red Light on Oyster-bed Shoal, and a long training wall with spurs on the north side of Saint Michael's Channel, which extends from Tybee Knoll to Tybee Roads. Aggregate length of works 28,000 feet, approximately.

7. A dam across the south channel, about half a mile below the entrance of Saint Augustine Creek, and a low closure dam across that creek near its mouth. Aggregate length about 1,800 feet.

8. Three spur jetties on the northeast shore of Tybee Island, aggregating about 5,400 feet in length.

9. Shore protections. Captain Greene indicates four places where the shores of the north channel should be protected to any considerable length, viz:

	Feet.
a. South Carolina shore, opposite Spirit Island	4,300
b. North shore of Elba Island, near its lower end	1,200
c. Jones Island, at and above Venus Point	4,000
d. Northeast shore of Long Island, central portion	5,000
Total length, approximately	14,500

The total length of these various works would be 84,000 linear feet, approximately, to wit:

	Feet.
Training-walls (Hutchinson's Island and Tybee Knoll)	20,000
Spur jetties, except at Tybee Island	40,400
Spur jetties at Tybee Island	5,400
Shore protections, as enumerated	14,500
Closure dams (Duck Puddle South Channel, Saint Augustine Creek)	3,700
Total	84,000

As to the height of the wing-dams, Captain Greene recommends their heads to be 3 feet high above low-water, and their shore ends up to level of high-water. The heads to be of T shape, and the banks near the roots of the spurs protected. He says nothing about the height of the closure dams embraced in his plan, but thinks that the dams closing the lateral channels below Elba Island, previously approved, should be raised to the level of high-water, with the possible exception of the dam at Philbrick's Cut, at the lower end of Elba Island.

Dredging would be done in the vicinity of the dams where necessary, and the material dumped behind them. He deems it of the greatest importance that government should procure and own a suitable dredge for that purpose.

The materials of which the works are chiefly to be constructed to be logs, brush, and stone, in the most economical proportions, employing stone as sparingly as consistent with safety.

As the best method for performing the work, he suggests buying the material in market and putting it in by hired labor.

The total cost of all the works described or designed by Captain Greene is estimated by him at $600,000, or near that sum. The sum to be paid for land damages on Hutchinson's Island opposite the city is not included in the estimate. He thinks it quite possible that the works will not at once be required of the height indicated by him, but that in time they will be. The purchase of plant for carrying on the works of construction is estimated at $20,000; the purchase of dredge, tug, dump-boats, &c., at $35,000.

Mr. Fremont thinks that the water-way of the north channel, from below Spirit Island to below Venus Point, should be continued at about the same width that now exists between Spirit Island and the north shore, or about 1,000 feet, the contraction to be effected by low dams, perpendicular or parallel to the direction of the current from or along both shores. If spurs are used, he recommends a maximum interval between them of 800 feet, which, if needed, may be reduced by supplementary works.

North of Cockspur Island he recommends the construction of two training walls. One of them would extend from the Horseshoe Shoal to the Red Light Beacon on Oyster-bed Shoal; the other along the north side of Saint Michael's Channel.

The cost of all these works, supposed to include some dredging, is estimated by him at $350,000.

A jetty or training wall at the lower end of Fig Island, extending in an easterly direction, forms part of his plan, and he proposes to connect its eastern end by a low dam with Barnwell Island. Probable cost estimated at $35,000, including deepening of the new channel at "The Wrecks" to a mean low-water depth of 17 feet.

Mr. Fremont estimates that nearly 800,000 cubic yards of material including 20 per cent. extra for errors in calculation) must be removed from the Savannah River in front of the city to establish a uniform width of 600 feet, and sufficient depth to enable vessels to be moved from wharf to wharf at any stage of tide. The cost of removing this material is estimated at $95,000. At the time when Mr. Fremont made this report the commissioners appointed to render an award for land damages at Hutchinson's Island had not yet come to a decision. As a preliminary estimate, he assumes the probable cost to be $100,000.

The dam at the Cross-Tides is not specially referred to in the report, but the sum of $10,000 is named in the general estimate to be used for the purpose of raising the dam properly.

The estimated aggregate cost of all the improvements, summarily pointed out in Mr. Fremont's report, is therefore $590,000, including land damages.

Mr. Fremont briefly refers to the fact that the main current of the north channel suddenly leaves the concave shore near the lower end of Elba Island and passes over to Venus Point, whence it is deflected southward to Long Island, to cross again to the north, impinging upon Oyster-bed Shoal opposite Cockspur Island, dividing there into two channels.

He concludes that, under the influence of the prevailing northeasterly winds, the line of deep water would generally be on the southerly side of the north channel, but that it is deflected and driven northward by the strong ebb currents from the lateral channels below Elba Island. He is inclined to think if these channels were closed (an operation already decided upon and now in progress) that the natural course of the main channel would be along the southern shore from the lower end of Spirit Island to near Cockspur Island.

It is seen that Captain Greene and Mr. Fremont substantially agree in regard to the means thought to be necessary for the further improvement of the Savannah River and Harbor. Both consider it necessary to raise the dam at the Cross-Tides much higher than it now is, to contract the water-way of the north channel below Spirit Island, and to protect Saint Michael's Channel below Tybee Knoll by a training wall. They differ in regard to the treatment of the reach of the river from below the Fig Island jetty, recently approved by the Chief of Engineers and now in course of construction, to the head of Elba Island. Captain Greene proposes to guide the navigable channel on its north side by a series of spurs, while Mr. Fremont would throw a low dam across the lower entrance of Back River.

It is to be regretted that the dams intended to close the side channels below Elba Island have not yet been constructed, owing to the utter failure of the contractor to accomplish anything. His contract was annulled on May 19, 1881, and the preparations for doing the work by hired labor with material bought in open market, and for procuring the requisite plant, consumed so much time that actual operations could not be commenced until recently. If these dams had been finished, and the submerged dam across the south channel at the head of Elba Island been raised somewhat higher, the observed effects of these works would have furnished valuable information in regard to the question of what may be needed for a further and permanent improvement of the lower Savannah River.

There can be no doubt, however, that the water-way of the north channel should be contracted where it evidently is too wide, and the real question is the number and extent of the works to be constructed, the sites for which are indicated in a general way by the river itself.

A radical solution of the problem would consist in confining the river between training walls or bulkheads all the way down to Tybee Roads, increasing the space between them in approaching the lower end. This was the latest form according to which the river Clyde was improved; and the river Maas, from above Rotterdam to its outlet into the North Sea, was similarly treated. By such an arrangement the currents of the ebb and flood tide would be compelled to follow the same channel, and the result would be the maintenance of a navigable water-way of ample depths. The expense would be very great, however, even if the training walls were carried up to the level of half-tide only, as in the case of the river Maas, and a further discussion of such a project appears to be premature at the present time.

A more economical method of improving the river at those places where it is too wide and of insufficient depth is offered by the employment of wing-dams or spur-jetties. By a proper disposition of such works it is believed that, without excessive cost, a permanent channel may be established of sufficient depth to enable vessels of 22 feet draught to pass from Tybee Roads to the city on the flood-tide, which is the maximum draught contemplated in the project previously submitted for the improvement of this tidal stream. No greater draught than this can be safely carried over the Tybee Bar except on the high-water of spring tides, and not even then unless the sea is more than ordinarily calm.

It is well known that the first real improvement of the river Clyde was obtained by means of a number of rubble spurs, which were built by John Golborne in the years from 1773 to 1775, and aided by dredging on the hard shoals. Where in 1769 only 2 feet depth of water at low-tide had existed, these works had in 1775 created a channel of 300 feet width and 6 feet 10 inches depth, which, at the end of the next six years, according to Mr. Golborne's statement, had increased to 12 or 14 feet, while the spaces between many of the jetties had become filled up and covered with grass. A great number of additional jetties were built at the beginning of the present century, by the advice of John Rennie, who also recommended to connect the heads of the spurs by continuous low rubble walls, which is believed to be the first instance of the adoption of the system of longitudinal training walls.

In regard to the question of the number and size of the works needed for contracting the river, the following remarks are offered:

The channel-way of the Savannah River, like that of most other rivers in their natural condition, presents a succession of extended and comparatively deep pools, separated by reaches of shoal water. It would seem that the more economical plan of improvement will be to construct works in the shoal sections of the river, designed to produce channels of adequate depth and of sufficient length to connect the deep pools. It is obvious that this method naturally leads to the preservation of the present line of channel, to which there seems to be no special objection. It is true that the channel is somewhat crooked, but the curves have large radii, and, so far as known, have never been considered as an impediment to navigation. To attempt to straighten the channel would throw some of the works into the deepest water and render them more expensive. It may be said, also, that the causes which tend to throw the main current of a river alternately from one bank to the other are generally rather obscure, and it seems advisable in the present case to accommodate the works to the natural course of the main current where it is practicable, instead of attempting to change it violently.

The deepest pool is found at the head of the north channel, between Spirit Island and the shore of South Carolina. At the narrowest part, at low-water, the width is 1,055 feet, with a mean hydraulic radius of

20.4 feet, and maximum depths of from 35 to 40 feet at mean low-tide. The 18-foot curve or pocket commences at a point above Spirit Island and ends opposite the lower end of that island, its length being about 8,000 feet.

At the easterly end of Spirit Island the north channel widens to 1,800 feet, with a hydraulic radius of 12.75 feet at low-water. The deep-water channel of this profile is about 500 feet wide, with depths varying from 16 to 17½ feet. This may be considered, approximately, as a standard profile, representing a cross-section of the river as it should be when improved as proposed.

Passing below the confines of Spirit Island the river rapidly widens; three-quarters of a mile below the width is over 4,000 feet, with corresponding shallow water. The low-water depth of the navigable channel in this vicinity is estimated at 12 feet, or a little over, but on a very limited width.

From this point down the river gradually narrows, and at the lower end of Elba Island another pool is formed. The total width is here about 2,500 feet, and in the deep water-way near the island low-water depths of 30 feet and upwards are found. The 18-foot pocket extends about parallel to the island shore for a length of about 3,600 feet.

The river then again widens, and at the mouth of the north channel, between the southeasterly point of Jones Island and the middle portion of Long Island, the width is about 4,700 feet, with available low-water depths of from 13½ to 15 feet in the channel-way. The main current passes from Elba Island across the river to the north shore of Jones Island, where it forms a third narrow pool, with depth varying from 18 to 26 feet for a length of about a mile.

Along the shore of Long Island a good navigable channel exists, the maintenance of which is probably due to the slight concavity and comparative toughness of the banks. The low-water depths reach up to 20 and 21 feet; but these depths are lost near the lower end of the island and beyond, in consequence of the weakening of the ebb-currents by the rapid expansion of the waters as they appreach Tybee Roads.

The large shoal or island partly bare even at high-water, north of Fort Pulaski, known as Oyster-Bed Shoal, divides the ship-channel into two arms, of which the southern one, since 1872, has been selected for use and has been deepened by dredging. It was, and, to some extent, is now, obstructed by shoals and remnants of wrecks, and needs further improvement. The same is the case with the easterly continuation of this channel, from Tybee Knoll to Tybee Roads, known as Saint Michael's Channel, where vessels sometimes find trouble in passing.

The work of improving the Savannah River and Harbor, so as to increase the depth of the water from the bar up to the city to 22 feet, as provided for in the act of March 3, 1881, and which is interpreted to mean a depth that will permit vessels drawing 22 feet to reach the city on the flood-tide, requires not only the construction of certain works in the north channel, but also higher up, as far as the Cross-Tides, 4 miles above the city.

The various points where such additional works are believed to be needed, with the probable cost of such works, will now be briefly discussed, beginning at the Cross-Tides.

CROSS-TIDES.

The further improvement of the harbor of Savannah, and of that portion of the river immediately below the city, requires an increase of the flow of water in that section. For that purpose the submerged dam at

Cross-Tides, recently constructed, must be raised, as the strength of the currents across its low crest towards Back River, during ebb-tide, shows that too large a volume of water escapes in that direction and is lost to the Front River.

It was stated in the last annual report that the crest of the work then reached at several places up to the level of low-water, while at other points there was from 6 to 8 feet of water over it at low-tide; and that it might become advisable to raise the dam ultimately to the level of high-water. In the latter event no doubts are entertained that the work will have a beneficial influence on the navigable channel in front of and below the city, and the estimate of the cost of further improvement should therefore provide for that contingency.

There is a question whether a gap should be left in the dam for the passage of river craft. In view of the violent currents that are now frequently observed here, it is doubtful whether boats could safely pass through the gap when the crest of the dam on both sides the opening shall have been raised to high-water mark, and the danger of undermining on the down-river side of the dam will be considerable if a channel be left through it. In forming an estimate of the cost of completing the work up to the level of ordinary high-water, it seems to be safer to assume that no gap will be left.

Several hundred cubic yards of stone have been placed on the dam since July 1, 1881, and with the funds still on hand it is proposed to raise the work to the height of several feet above low-water.

IMPROVEMENT OF THE WATER-WAY BETWEEN CROSS-TIDES AND THE CITY OF SAVANNAH.

The distance from the Cross-Tides to the upper part of the city of Savannah is about 3½ miles. Some dredging has been done here of late, temporarily improving the channel near the Georgia shore, but as the proposed raising of the dam at the Cross-Tides progresses, some additional dredging should be done in this reach, with a view of more rapidly gaining the depth which the increased flow of water is to maintain. It is thought that the sum of $20,000 may advantageously be expended for the purpose.

ENLARGING THE WATER-WAY OPPOSITE THE CITY FRONT AND AT FIG ISLAND.

This improvement requires the cutting away of a strip of land on the Hutchinson's Island side, opposite the city, and a considerable amount of dredging along the city front on nearly the whole width of the river. It is contemplated in the existing project of improvement to widen the river to 600 feet, opposite the upper portion of the city, gradually increasing the width 650 feet near Fig Island, opposite the lower front of the city, and to deepen it sufficiently to enable vessels drawing as much as 22 feet of water to be moved from wharf to wharf at any stage of tide.

The length of the strip of land to be cut off is nearly 2,300 feet, averaging 62½ feet in width. The present front of Hutchinson's Island is wharfed, except about 500 feet of its length. The land is held by sundry parties, and is for the most part occupied by improvements, among which are a large saw-mill with log-pond, a ship-yard and marine railway, warehouses, machine shop, and oil works.

Negotiations for an appraisement and transfer to the United States of the necessary area of land, amounting to 3.3 acres, were commenced about a year ago, but have not yet been brought to a close.

It is understood, however, that the city agrees to give, and the landholders agree to accept, an equal area of land directly in rear of the land to be ceded. The United States are expected to pay the expenses of moving back or putting up again on the new sites the several establishments now existing, and of building wharves along the new river front.

From information recently received it is thought that the aggregate claim for damages will amount to about $75,000.

Assistant Engineer S. L. Fremont estimates that the strip of land must be cut away to a depth of about 20 feet. This would be equal to a volume of 106,000 cubic yards of material.

He further estimates that, in order to gain the desired depth of water along the city front on a length of about 4,000 feet, about 530,000 cubic yards of material must be removed.

The aggregate amount of material to be removed by excavating or dredging is, therefore, 636,000 cubic yards, and the cost of its removal will be about $98,000. This is expected to give a low-water depth of 22 feet on the city side of the river, so that vessels can load to their full draught and move from wharf to wharf at any stage of tide without grounding, while the rest of the channel will have a depth of only 22 feet at high-water.

It is not to be expected that a deep pool or basin thus artificially formed will maintain itself perfect by the mere strength of the currents, and occasional dredging will be necessary after it has been established.

Another improvement may be mentioned here. When the land on Hutchinson's Island shall have been cut away, and the new front lined with wharves, it will before long become desirable to extend the line of bulkheads on that side to near the lower end of Fig Island. The present excessive widths and irregularities of shore line opposite the city will then disappear, the tide currents will be guided as if by regular training-walls on both sides, and the maintenance of the increased depth of the harbor will be greatly facilitated and rendered less expensive. As part of the general plan of improvement, the immediate construction of at least two wing-dams, reaching from the north shore out nearly to the new bulkhead line, is deemed necessary, and has recently been recommended and approved. Pehaps a third one will also be required at an early day. Beyond this and the dredging above mentioned the General Government should not expend any more money opposite the city front, as the completion of the bulkhead line on the north side will doubtless be undertaken by private enterprise as soon as additional wharfage facilities are needed on that side of the stream. These three wing-dams will cost about $25,000.

The cost of improving the river in front of the city is therefore estimated at $198,000, viz:

Amount of claims for damages	$75,000
Excavation and dredging	98,000
Three wing-dams from Hutchinson's Island	25,000
Total	198,000

NEW CHANNEL AT "THE WRECKS."

Experience having shown that the new channel at "The Wrecks," running close to the south shore as the river emerges from the confines of Fig Island, cannot sufficiently maintain the depths obtained by repeated dredging, it was considered expedient to begin the construction of a work, the ultimate necessity of which has been indicated in several preceding annual reports, but had been temporarily held in abeyance. The work referred to is a deflecting jetty, or training-wall, extending eastward from the lower end of Fig Island. On my recommendation the design for its construction was approved by department letter dated November 4, 1881.

The jetty, if carried up to a height of 3 or 3½ feet above the level of low-water, will keep together the currents issuing from Front River during the latter stages of the ebb-tide, and may safely be expected to exert a very beneficial influence on the preservation of such depths as will be gained by dredging, and even to deepen the channel by its own action, especially when the dam at Cross-Tides shall have been built up to the height suggested in this report.

The total length of the jetty, as now designed, is 5,200 feet. It is built of log mattresses, overlaid with brush and riprap stone. Above the low-water line the latter material will be used liberally. The bottom course is already laid for a length of 2,040 feet, and a second course for a length of 290 feet, and the work will soon be carried up to the height of 2 or 3 feet above low-water mark on the entire length designed. If built up to the level of half-tide, except on the lower end, for a length of about 200 feet, which may gradually drop down to a height of about 3 feet above the bed of the river, to prevent troublesome scour at that point, the cost of this work is estimated at $30,000.

IMPROVEMENT OF THE WATER-WAY FROM THE VICINITY OF FORT JACKSON TO THE HEAD OF THE NORTH CHANNEL.

The distance from the lower end of the Fig Island jetty, here referred to, to Fort Jackson, on the south shore of the Savannah River, is about half a mile, and from that place to the head of the north channel, 2 miles.

Down to near the upper end of the south channel, 1 mile below the fort, the navigable channel passes near the south shore, which is slightly concave, and ample depths are found here. But on the reach abreast the head of Elba Island, of about 1 mile in length, part of which is known as "The Obstructions," the depths are much reduced below the standard desired. Through this reach the main channel passes from the Georgia to the South Carolina shore. Occasional dredging has given here but temporary relief, as is generally the case where an inflection of a river is to be dealt with.

It is necessary to direct stronger currents over these shallow places, and this can be effected by contracting the water-way. The wing-dams proposed by Captain Greene are well located for the purpose. It appears, however, that only those numbered 15, 17, and 19 on the chart sent with his report are immediately necessary, as they will act directly upon the portion of the river to be improved. Possibly No. 13 might be included, as it will produce an extension of the deep-water pocket now ending opposite the head of the south channel into the defective reach; and also dams numbered 5 and 11½, closing the channels on the northwest and southeast sides of Barnwell Island.

The other spurs above No. 13, to wit, Nos. 3, 7, 9, and 11, shown on the chart, are evidently designed to concentrate the outgoing waters of Back River, and guide its ebb-currents at a favorable angle into the main channel near Fort Jackson. They would undoubtedly assist in creating greater depths in the vicinity of "The Obstructions," but their construction does not seem to be of very pressing need, and should be postponed until demonstrated to be necessary.

In relation to this matter, the question may be raised whether it will be more advantageous to effect, just below the Fig Island jetty, by suitable works and at a favorable angle, the junction of the ebb-currents from Back River and Front River, or to promote the entrance of the flood-tide into Front River, and slightly obstruct its flow into Back River, through extending the Fig Island Jetty by a sill-dam in an easterly direction to the low islands opposite Fort Jackson. A low dam arranged as here suggested, though only about 3 feet high above the bottom of the river, would tend to guide the flood-tide currents into Front River, and would, in a measure, act as a submerged training wall for the waters flowing out during ebb-tide. Such a sill-dam would have a length of about 3,500 feet, and with a base of 30 feet width would cost about $25,000. The works proposed by Captain Greene, comprising Nos. 3, 7, 9, and 11, and three spurs on the north side of the Fig Island Jetty, would have an aggregate length of about 4,600 feet, and will probably cost, approximately, $40,000.

It is thought sufficient to include in the new project the two closure dams at Barnwell Island, and those wing-dams that are undoubtedly required to improve the ship-channel at "The Obstructions" and vicinity. They will be four in number, by including No. 13, of an aggregate length of about 3,000 feet. As a general rule, the height of the shore ends of these spurs may be about 7 feet above mean low-water for a length of 100 feet. For the following 200 feet of length the crest may gradually drop to a height of 3 feet above low-water level, from which point it may run out at a gentle slope to the head of the work next to the channel, where it may be not higher than 3 feet above the bed of the river. This will prevent the formation of deep holes caused by eddying currents at the head, and the deepening effects of the spur will be more evenly distributed over the width of the channel. In all cases the head is recommended to be in the shape of a T, to form a low training wall of from 300 to 500 feet in length, to extend the effect of the spur some distance above and below. It will also obstruct the currents that are generally found to run along the sides of wing-dams towards the channel, and will, moreover, in some measure, prevent the sediment which is dropped in the intervals between the spurs from being washed into the channel.

The elevation of the crown above the bed at the different points of the wing-dam may, of course, vary from the rule here suggested, but it is believed that with a longitudinal profile approximately like that described the desired effect will be realized, and the estimates have been made on that basis. As to the mode of construction, it is assumed that the crown will be uniformly 4 feet wide, with slopes of 1 to 1 on each side. All that portion of the dam from 1 to 2 feet above mean low-water is presumed to be of riprap stone; below, alternate courses of log or brush mattresses and stone, the latter used as sparingly as practicable. The bottom mattress is supposed to project about 5 feet beyond the foot of the slope on each side of the dam.

At present prices it is estimated that the four wing-dams designed for the improvement of the channel abreast of the head of Elba Island, together with the Barnwell Island dams, will cost approximately $45,000.

DAM AT THE HEAD OF SOUTH CHANNEL.

This work forms a part of the supplementary project of March 19, 1879. It was designed to increase the volume of ebb-flow in the north channel, and was intended to be a submerged dam, keeping a portion of it, for a width of 200 feet, at least 10 feet below mean low-water for the accommodation of vessels of moderate draught bound in or out of Saint Augustine Creek, which forms part of the inland passage to Florida.

Operations were commenced here some time ago, and at the end of the past fiscal year an apron or bottom course of mattresses of 24 feet width and 18 inches in average thickness, overlaid with some riprap stone, had been laid from the line of high-water on one bank, across the river, to the corresponding line on the other bank. A second and third course of narrow mattresses cover portions of the apron.

The original width of the transverse profile of the south channel at the site of the dam was 1,000 feet at mean low-water and 1,460 feet at high-water, with an average low-water depth of 13.3 feet, and a maximum depth of 20.5 feet. The works thus far executed have reduced these dimensions somewhat. The widths of the river at low-water and high-water are now 960 and 1,060 feet, respectively; the average low-water depth is 10.4 feet and the maximum depth 18.5 feet. The area of cross-section has been reduced from 13,330 square feet to 9,950 at low-water, and from 21,150 square feet to 17,070 at high-water.

It appears necessary to raise the dam higher to produce appreciable effects. It is proposed to reduce the average low-water depth to about 5 feet, and perhaps still more, leaving a gap as originally designed.

An estimate of the probable cost of this work is given in the project of March 19, 1879, and is judged to be ample, even if the dam is raised higher as above indicated.

IMPROVEMENT OF THE WATER-WAY OF THE NORTH CHANNEL FROM THE HEAD OF ELBA ISLAND TO THE LOWER END OF JONES ISLAND.

The length of the present ship-channel in the several reaches embraced in this section of the river is about 6½ statute miles. Three comparatively deep pools, with low-water depths from 17 feet upwards, are found here, of an aggregate length of about 3 miles. The upper and lower pools are located on the north or South Carolina shore of the river; the middle one on the south shore near the lower part of Elba Island. The shoal reaches occupy the places technically known as inflections, where the principal current passes from one bank to the opposite one, and these are the places that must be improved by suitable works.

The solution of the problem consists in concentrating the scattered currents upon the line adopted for the ship-channel, to produce greater depths by the scouring action of stronger bottom currents, aided by dredging where the bed is refractory.

It is proposed to effect this concentration of currents in the shallow reaches by means of spurs or wing-dams projected into the river from both banks, leaving ample width between the heads of each set or pair of spurs for a low-water channel. A few jetties will be required for each shallow reach, generally in pairs, although there will be points where one jetty will suffice, with some works for protecting the opposite shore from abrasion. Each wing-dam should be provided at its head with a low training wall, about 500 feet long, parallel to the channel-way.

When two adjoining spurs are too far apart, it is proposed to mark the margin of the deep water-way by a detached length of training wall, with a short spur in rear, not connected with the shore. To promote the deposit of sediment, light traverses may be built at suitable places.

In all cases the heads of jetties should be kept very low, and the crown should rise at a very gentle slope towards the high shore ends, as already described.

It is expected that between the heads of every pair of wing-dams the bed will be deepened by scour to a greater depth than required, forming, in fact, secondary pools, overlapping the heads of these works for some distance in the direction of the channel, while gradually diminishing in depth. It is not thought to be necessary that the ends of these pools, where they are reduced to the desired minimum low-water depth of about 17 feet, should actually or at once join the ends of similar depth of the large or primary pools already existing, by the direct action of the wing-dams alone. The work of joining the secondary pools with the primary ones may be left to the river itself by gradually, more or less, filling up the intervals between the spurs, and thus reducing the area of the water-way above and below them.

The location of the wing-dams designed for the improvement of the north channel, shown on the chart sent with Captain Greene's report, are considered to be approximate only, and subject to modification; but they furnish a general idea of what is required. It is thought that the desired end can be obtained without giving the works in each case the full length indicated on the chart.

As an illustration of the probable effects of the wing-dams if constructed as suggested, the spurs numbered 6 and 25, which appear to be judiciously located about 800 yards below Spirit Island, will be briefly considered. It is not the intention, however, to present a lengthy discussion of the theories bearing upon this subject.

When the north channel was gauged some years ago, the average discharge during the ebb-tide, in the principal water-way between Spirit Island and the north shore, was found to be about 42,800 cubic feet per second; in the shallow channel south of Spirit Island, 3,370 cubic feet. The aggregate ebb volume that passes through the transverse profile where the two wing-dams spoken of are to be built, may, therefore, be estimated at 46,170 cubic feet per second.

An examination of detailed charts has furnished the following data for this profile:

	Area of water-way.	Width.	Hydraulic radius.
At low-tide	26,079 square feet.	3,642 feet.	7.16 feet.
At half-tide	37,990 square feet.	3,687 feet.	10.18 feet.

Assuming that at half-tide the discharge is equal to 46,170 cubic feet per second, we find by the Daubuisson-Downing formula for the mean volocity V:

$$V = 100 \times \sqrt{R \times S};$$

where R = hydraulic radius and S = surface slope, that $S = .00001451$. This represents the surface slope of the unimproved river.

The spur on the north side is designed to be 1,300 feet long; that on the south side, 750 feet; their heights as already indicated. These works will reduce the width of the profile from 3,642 feet to 2,672 feet at low-tide, and from 3,687 feet to 3,182 feet at half-tide, leaving a clear space between the heads of the jetties of 1,642 feet.

When the scouring effects produced by the wing-dam shall have been practically exhausted, aided by dredging, if necessary, the former slope will probably be restored; and the question is, what depths may be found then in the open water-way between the heads of the works.

The result of the calculation is briefly as follows:

The new profile may be divided into two compartments: a shallow one, the bottom of which is formed by the submerged crest of the wing-dams, and a deep compartment between their heads.

The aggregate width of the shallow compartment, at half-tide, is 1,540 feet; its area, 6,444 square feet; and its hydraulic radius is 4.12 feet. With an average slope of .00001451, the discharge over the jetties will be 4,200 cubic feet, deduced by using Young's coefficient (84.3) in the formula as more appropriate than Downing's (100), where the hydraulic radius is so small.

The balance, or 41,970 (=46,170 less 4,200), must flow out between the heads of the dams. The width of this water-way being given, the new or modified hydraulic radius of the enlarged water-way is determined by the formula:

$$R^3 = \frac{Q^2}{10.000 \times p^2 \times S}; \text{ in which } \begin{cases} Q = \text{volume of discharge.} \\ p = \text{wetted perimeter.} \end{cases}$$

In getting this equation, the formula for the velocity with Downing's coefficient of 100 is employed as being applicable to the deep-water compartment.

By inserting the values given, it is found that $R = 16.35$ feet, the hydraulic radius at half-tide.

It is generally assumed that the proportion of the radius to the depths prevailing in the deep channel of the water-way of a river is, approximately, as 2 to 3, and we may therefore expect to find depths of 24 or 25 feet at half-tide, or about 21 feet at low-tide, in a width of several hundred feet between the spur-heads.

By examining the most recent detailed charts of the north channel it is found that at the ends of the existing pools the points of 16½ or 17 feet depth are quite uniformly from 800 to 1,000 feet from the 21-foot curves of the pools.

It may be expected that the wing-dams will bring about similar results, and that they will create sufficient depths for as great a distance above and below them. The low training-walls at the heads are designed not only as guides to the current but also to push out still further the deep pockets artificially formed. The gradual accumulation of deposited material, and the building out of the old shore lines between the wing-dams, will, it is hoped, finish the work.

It must also be borne in mind that every inch permanently gained in depth will augment the volume of the flood-tide ascending the river, and will produce stronger ebb-currents.

The closing of the lateral channels below Elba Island by high dams will soon be under way. The irregularities produced in the north channel by these secondary water-ways will then cease, and the cost of the works proposed in the present project will probably be reduced thereby, although it would be neither practicable nor safe to attempt to form an estimate of the saving that may be effected.

In making an estimate of the probable cost of improving, in the manner described, the north channel from the head of Elba Island to the lower end of Jones Island, it has been assumed that on the north side eight wing-dams of an aggregate length of about 8,000 feet, with low training-walls at their heads, aggregating 3,400 feet in length, will be constructed, also a detached piece of training-wall of 500 feet length opposite the central portion of Elba Island. On the south side six spurs are assumed to be built of a total length of 7,000 feet, with about 1,700 feet of training-wall. The total cost of these works is estimated at $160,000. The longest of the wing-dams would be located at the southeast point of Jones Island; it will extend about 1,750 feet in a southerly direction toward Long Island, and from its head will spring a training-wall extending eastward, and to be mentioned further on.

IMPROVEMENT OF SAVANNAH RIVER FROM THE LOWER END OF JONES ISLAND TO TYBEE ROADS.

No work has yet been done for improving this section of the river beyond the opening of a new channel through the shoal northeast of Fort Pulaski, by dredging, and the removal of wrecks and dredging on the Oyster-Bed Shoal, north of Cockspur Island. It is necessary to cause a larger volume of water to flow through this passage. The eastern continuation of this channel that leads into Tybee Roads, known as Saint Michael's Channel, is also subject to shoaling from sand driven in on the north side by the currents from Calibogue Sound and by breaking waves rolled in by the northeasterly gales.

The probability that the discharge into Tybee Roads will have to be controlled or directed in some degree by suitable works was recognized in the supplementary project of March 19, 1879, but no estimate of the cost of such works was therein submitted. It was said that a simple sill jetty or low training-wall rising from 3 to 4 feet from the bottom, and running from a point at or near the lower end of Jones Island to the Oyster-Bed Beacon (Red Light), and perhaps a short distance beyond, would doubtless suffice.

Such a work seems to be rather preferable to the long jetty suggested by Captain Greene to be run from Turtle Island to Oyster-Bed Shoal, and marked No. 37 on the accompanying chart, which is apparently designed to prevent, in a measure, the waters of the estuary between Jones and Turtle islands, and just south of these islands, from flowing out eastward, and to compel them to increase the flow in the Cockspur Island Channel. Its beneficial effect does not appear to be as evident as that of the jetty or training-wall from the lower end of Jones Island, which, in fact, will perform services at the mouth of the river similar to those to be rendered several miles above by the jetty now in course of construction from Fig Island, and designed to protect and improve the new channel at "The Wrecks."

The jetty from Jones Island would begin at or near the outer end of the long wing-dam at the southeast point of that island, and would run in an easterly direction to the vicinity of Red-Light Beacon and the quarantine station, having a length of about 10,000 feet.

The more elevated portion of Oyster-Bed Shoal would form a natural continuation of this jetty, which would then be extended still further eastward for the protection of Saint Michael's Channel. The aggregate length of these works is about 20,000 feet, and it is thought that they can be built at the rate of $7 per linear foot if they are about 4 feet high. Their construction will, therefore, cost about $140,000, and this sum may be adopted for the estimate, whether the work runs from Jones Island or from Turtle Island, the selection of a location for the line of works being left open for the present.

None of the other wing-dams or training-walls intended for the improvement of this seaward portion of the river, and shown on Captain Greene's chart, are recommended as strictly necessary at the present time, and may, perhaps, not be required at all, with the exception of one or two spurs from Cockspur Island, which would be useful and effective for concentrating currents on the shoals south of Red-Light Beacon.

The aggregate length of these spurs is about 1,500 feet, and their probable cost is estimated at $20,000.

SHORE PROTECTIONS.

The places where the banks will probably require to be protected from abrasion or undermining are shown on the chart, and are marked thereon Numbers 16, 21, 28, and 31. An estimate of the probable cost of this class of improvements was embodied in the supplementary project of March 19, 1879, which was thought to be sufficient for the purpose.

DREDGING.

More or less dredging will yet be required on the following portions of the ship-channel below the city of Savannah:

1. The new channel at "The Wrecks."
2. The channel at the head of Elba Island.
3. The shoals abreast of Elba Island (upper flats).
4. The shoals at lower end of Elba Island (lower flats).
5. The shoals between Jones Island and Long Island.
6. The channel at Oyster-Bed Light and further down.

It is proposed to carry on the dredging operations in conjunction with the construction of the works intended to concentrate the currents at the same places, as far as practicable, in order that they may support each other. For merely temporary relief of commerce, dredging will in future be resorted to in exceptional cases only.

In the estimate of the cost of this kind of work given in the supplementary project of March 19, 1879, it is assumed that dredging would be restricted to the places below Elba Island of less depth than 14½ or 15 feet at mean low-water, excavating a channel of 125 feet bottom width with side slopes of 1 to 2. On this basis the total cost of dredging needed below the head of Elba Island was estimated at $97,000.

ESTIMATE OF AGGREGATE COST.

It is submitted that the works hereinabove described, with such modification in the number, location, and magnitude thereof as experience and observation may suggest during the process of construction, will be required in accomplishing the improvement contemplated in section 3 of the river and harbor act, approved March 3, 1881.

Their aggregate cost, including land damages in addition to existing appropriation, is estimated at $730,000.

An economical construction of the works still required for improving Savannah River and Harbor seems to require the continuation of the system recently inaugurated, that is, that government should do the work itself, wherever practicable, with the plant already provided. Operations can then be carried on continuously, and special modes of construction can be introduced from time to time, whenever it may be thought to be desirable.

There has been appropriated for the improvement of Savannah River and Harbor since the project of August 28, 1873, was submitted, the sum of $482,000; and there has been expended to December 31, 1881, including outstanding liabilities, the sum of $352,355.

Regarding the question of the benefits that will accrue to commerce and navigation by completing the work of improving Savannah River and Harbor according to the project herewith submitted, I beg leave to refer to the remarks made on that point in my annual report to the Chief of Engineers for the fiscal year ending June 30, 1881, as well as to preceding annual reports.

This work is located in the collection district of Savannah. Savannah is the nearest port of entry.

The amount of revenue (duties on imports) collected during the last fiscal year was $74,458.41.

The following papers are transmitted herewith:

1. Report of Capt. B. D. Greene, Corps of Engineers.
2. Report of Assistant Engineer S. L. Fremont.
3. Chart sent with Captain Greene's report.

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Lieutenant-Colonel Engineers,
Bvt. Maj. Gen., U. S. A.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF CAPTAIN B. D. GREENE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., June 25, 1881.

COLONEL: I have the honor to submit the following general report upon the improvement of the Savannah River below Savannah, with proposed plan of construction and approximate estimate of the cost.

Sufficiently detailed descriptions of the physical features of the Savannah River, and the difficulties attending its navigation have been presented in your several annual reports since 1872. Briefly summarized they may be given as follows: The Savannah River reaches the vicinity of the city of Savannah having a low-water discharge of about 8,000 to 10,000 cubic feet per second. At a point about 3 miles below the city it is stopped in its flow by the tidal current entering the channel-way. This tide backs the fresh water for a distance of 28 miles above the city. It has the effect to double the fresh-water discharge, in a consideration of the water-way required below the city. The mean rise of the tide at the city is about 7 feet. At the city the tidal current has the effect to again double the flow of the river, thus, in all, requiring provision for a discharge of about four times the proper discharge of the river. At a point about 3 miles above the city the river divides into two channels, known as the Front and Back rivers. This point of division is known as "The Cross-Tides." The Front River, which carries about one-third the whole volume of flow, is from 600 to 800 feet wide. The Back River is about double this width, and has a corresponding discharge.

Below the city again, but above the point where the tide stops the river flow, the channel is divided into two parts, known as the North and South rivers. Here again the volumes of discharge are about as 2 to 1 in favor of the north channel. This division continues to the mouth of the river.

At two or three points intermediate there are narrow and shoal connecting waterways between the two channels. About 1¼ miles below the head of the south channel there diverges from it a slough known as Saint Augustine Creek, which forms a part of the interior water communication with Florida. The north channel, about 5 miles below its head, becomes wide and flat, separates into several minor channels, which wind about among shoals that are generally of hard material and permanent in their form and position. The islands separating these channels are low. The banks are low and are composed of a soft, sticky mud resting on sand or shells.

These banks will yield to increased current and fall in a low-water. The north channel, being the present ship-channel as well as the natural channel of the river, has been selected for improvement below the city. At the city, many who are interested consider the present width of the river, 650 feet, as entirely inadequate to the future demands of the commerce involved.

In view of the large expenditure of money required to give deep water to the city, however, it would be very injudicious to propose any improvement in this direction for many years to come. To obtain and secure a deep channel to the Tybee Roads will require the contraction of the water-way the entire distance.

This contraction, and at the same time a gradual increase in width, may best be reached by arranging some of the dams so that they may form tidal basins at intervals as frequent as may be practicable. It appears from present information that the Back River behind Hutchinson's Island, the upper end of the south channel, the central portion of the south channel just below dam 8, and the vicinity of Horseshoe Shoal above the Oyster Bed may serve as such reservoirs. Some dredging may be necessary, but the value of dredging in effecting any permanent improvement is generally much overestimated. A low dam has been built at the Cross-Tides across the Back River. This dam is so low that it has, to all appearances, no effect upon the river. It will require to be raised to a height of about 4 to 6 feet above low-water. At present it is that much *below* low-water. This dam, however, should not be raised at present or until the Wrecks Channel is secured. A dam has been commenced at the head of the south channel. Not enough has been done on this dam to have any influence on the current. The gauging of the river in 1878 and 1879 was necessarily only approximate, and but little use can be made of the results. Probably, as generally happens in such cases, the discharge obtained is much too large. It seems, as nearly as may be estimated, that the channel, 650 feet wide at the city, may be widened to 1,000 or 1,200 feet below the head of Elba Island and thence gradually increased to a width of 1,500 or 2,000 feet at Tybee Roads.

The Coast Survey chart accompanying this paper shows the general and approximate location of wing-dams and shore protections that may be required. The closing dams should be built very nearly to high-water, except at Philbrick's Cut, where, perhaps, probably, in fact, the ebb-tide might be drawn off over a low dam and directed by the adjacent wing-dam (No. 14) upon the shoal crossing at that point. If not found to fulfill this expectation, it can be raised to the height of the others. The wing-dams will generally be at their outer ends about 3 feet above low-water level, and at their shore ends up to high-water mark. They will, of course, have the shores near them protected, and also have T-heads of suitable proportions, say in general about 100 or 150 feet in length. One dredge could be profitably employed in deepening the channel in the vicinity of the dams and dumping the material behind the dams. This dredge should be strong and efficient, and should be owned by the government.

PLAN OF CONSTRUCTION.

The materials of which these dams may be built are logs, brush, rock—their cost being in the order they are mentioned, the cost of the rock being about double that of the logs. Economy will require the use of the greatest number of logs and minimum of rock. Probably these proportions will be found to be 2 to 1. In combining logs and rock, some plan should be adopted that requires the least labor, and that not skilled labor. The plan of alternate layers is such an one. A cross-section of dam 10 feet high, with wide apron, is shown on the tracing. This has only 6 inches of rock, and that only partly covering each layer of logs. A dam of this height will cost about $13 per linear foot. Considering that most of the dams will be built in quiet water and partly out of water, it seems probable that this extensive use of logs can be made. The shore protections may be made almost entirely of smaller logs or poles, 6 inches or 8 inches diameter; these to be laid along the bank and held in position by a little rock on the outer edges and stakes on the upper edges. If necessary, small piles can be driven at intervals, with a projecting iron bolt to catch over the binding poles of the mat, and hold the middle down.

COST.

Estimating log mats at 50 cents per square yard, and rock at $3.50 per cubic yard, which may be taken at the maximum prices, the cost of the works indicated on the map will not be far from $600,000.

This is a large sum. It may, perhaps, be reduced somewhat by leaving out some of the works; by locating them somewhat differently when the nature of the bottom and currents is better understood; by introducing more logs, as, for instance, a double raft for the foundation; by building some of the wing-dams of a less strong section, on a different plan, as with piles and rafts sunk alongside of them, &c. In general, however, the section herewith given is none too heavy for stability, and it need not be expected that a depth of 17 feet can be reached and maintained for less money than the sum named. For a great part of the distance the Savannah River, below the city, is to a certain extent an open roadstead. This will prevent a resort of those inexpensive devices which may be used on a non-tidal river. The deposit of sediment from the mingling fresh and salt waters must be borne away by a strong current.

Before closing this it may be proper to refer to the Cross-Tides Dam. This dam should, I think, be built up to the high-water mark, and the Back River at that point entirely closed. If an attempt be made to raise it, and leave a gap for boats to use, it will be somewhat difficult and expensive to maintain the dam, and the current will be so strong that boats cannot very well use it. The placing of a few hundred yards of rock on the dam would not help the cutting of the bank, which can be better controlled by the protection now on it. It may possibly be necessary to place a mat below the dam to prevent its undermining. This will certainly be necessary if the dam is raised and a gap left in the middle. I think nothing should be done until work No. 1, at the foot of Hutchinson's Island, is complete, when it may be raised without endangering the Wrecks Channel. It would probably be better to leave it until dam 8 is built. This dam is located on the line of uniform section, and where the dam can be built for much less money than at any other point. As to the other works, their location is the result of some consideration, and in all cases with a view to their economical construction. It is quite possible that they will not at once be required of the height indicated by the estimates, but in time they will demand that quantity of material.

The matter of a dredge I regard as of the utmost importance in the prosecution of this work.

The situation, circumstances, and climate are such that no dredging outfit can be got there except by building, and this should be at once done. If the United States buys the material in market and puts it in by hired labor, and has a good dredge to use when and where it may be most advantageous, there will be nothing in the way of bringing this work to a prompt and successful issue.

Very respectfully, your obedient servant,

B. D. GREENE,
Captain of Engineers.

Lieut. Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

REPORT OF MR. S. L. FREMONT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Savannah, June 21, 1881.

SIR: As suggested, I submit my views upon the subject of future works of improvement for the Savannah River.

Assuming that the works already projected and approved by the Board of Engineers (in its report on the 25th of July, 1879, so far at least as the closure of the openings between the islands and the construction of a low dam at the head of the South Channel) are to be completed, I think the following is substantially the project that should be adopted for continuing the improvements of the river from Spirit Island to Tybee Roads.

Opposite the mouth of Mud River, below Spirit Island, there is a shoal of very soft mud, or "silt," that should be removed by means of wing-dams or training-walls. I am rather in favor of the latter. I think the water-way should be continued at about the same width that now exists between Spirit Island and the northern shore, say 1,000 feet, by the construction of low dams perpendicular or parallel to the direction of the current, from or along both shores, and, if wing-dams, at such intervals, measured along the shores, as shall be thought best, but at first these distances may be taken at the maximum, say 800 feet, and if found necessary the intervals may be reduced by supplementing others. These dams can be constructed, it is thought, at a cost of about $7 per linear foot.

This process of narrowing the water-way should be carried to the lower "flats," or shoal near "Philbrick's Cut," thence to Venu's Point, or along the island shore, as may be considered best.

Here a question arises, which would have been fully answered and effectually decided by the action of the current long since, if the contract for closing the openings between the islands had been executed as designed, and the dredgings been used to fill the cribs. Why does the current so suddenly leave the concave south shore and cross over to Venu's Point? Why does it leave Venu's Point and recross to the south or Long Island shore? Why does the channel again cross to the north side, impinge upon the Oyster Bed, and divide? These are pertinent questions, and upon their solution depends the course we should pursue in improving the river and deepening a channel between "Philbrick's Cut" and the Oyster Bed.

I find the following facts to exist along the Savannah River, from the Cross-Tides to the sea: Other things being about equal, that is, where no obstruction is offered the current, deep water is found on the southwest side of the river, which usually forms a concave shore line. This is apparently due to the prevailing winds—storm-winds—from the northeast, when the largest amount of scouring takes place. Let us apply this principle. At the breaks in the south shore line at "Philbrick's Cut," openings between Bird Island and the islands north of it, and Bird and Long islands, the strong ebb-flow deflects the currents of the main channel to the northeast side of the river, where it is sheltered by Jones Island until the end of that island is reached, when the prevailing winds again drive the current back to the south shore at Long Island. Passing along the shore of Long Island to the cross-current between it and Cockspur—as it existed there three or four years ago—the main current was driven to the northeast side near the Red Light, from thence dividing into two channels. Thus we see most clearly why the channel of the river is in this portion of its course deflected from one side to the other—first to the north side by the cross-currents caused by the openings between the islands. When the protection of Jones Island ceases to exist, the prevailing winds drive it back to the south side, where it continues alongside of Long Island until the cross-current from the opening between that island and Cockspur again forces it over to the Red Light and Oyster Shoal.

Such seems to me to be the history of this crooked channel. Whether it is best to straighten it or not we can best judge by estimating the cost of opening the one now not in use, and the cost of maintaining the one now in use. The distance to be dredged along the island shores is 3,600 yards, and the average depth to be cut is 6 feet or 2 yards, and width of cut 120 feet or 40 yards. The amount of material to be removed would be 288,000 cubic yards, and, at 15 cents per yard, would give us a cost of $43,200. One-third of this at least was to have been removed and used in filling the crib-dams.

What the cost will be of deepening and maintaining the other channel I do not know, but leave that to your more accurate estimates, as I am entirely indifferent as to which side of the river the channel shall be made to conform; I want to secure the best. It seems to me, from my discussion of the subject, that the natural course of the channel would be along the south shore when that shore shall have been established. It looks, both on the map and on the river, that the natural sweep of the current from the lower end of Spirit Island to near Cockspur would be along the slightly concave shore of islands. With this explanation I am ready to concur in the adoption of either channel as you may prefer.

FROM THE OYSTER BED TO TYBEE ROADS.

There should be a training wall across the old channel, known more generally as the "Quarantine Channel," from the "Red Beacon Shoal" to the "Horseshoe Shoal," and another training-wall along Saint Michael's Channel across a portion of the mouth of Calibogue Sound, which occasions a drift of sand into the ship channel.

I send you a tracing from a Coast Survey map which has the works of improvement, so far as I am able to judge of them at this time, laid down.

Estimates based upon any information that we now possess would be very unreliable, yet I have ventured an approximation.

HARBOR OF SAVANNAH.

It is proposed to give the harbor of Savannah a width of 600 feet where it is now narrower than that, and a depth sufficiently great to enable vessels to be moved from wharf to wharf at any time of tide. This will require an average deepening of at least 6 feet for a width of 600 feet and a length of 3,960 feet. The widening required will extend along Hutchinson's Island for a distance of 2,530 feet, and the surface cut off will average 65 feet in width, and will require a depth of 20 feet to be cut, which will give 121,815 cubic yards of material to be removed. To this add the amount of material to be removed from the bottom of the harbor to give it the proper depth of water, 533,000 cubic yards, and we have 654,815 cubic yards of material to be dredged from the harbor of Savannah during the next fiscal year. Now to this add 20 per cent. of material for contingent losses in calculations in estimating, and we have 785,778 cubic yards of material to be removed.

The accompanying sketch of the harbor will show you the line to be cut off, and the general form of the harbor proposed. The soundings are only approximate, no survey having been made, except in a few places, in several years.

The Wrecks Shoal, where a low training-wall for the protection of its surface and the ultimate conversion of it into a northern shore of the Savannah River at this point, is shown. The training-wall should connect with a low dam across Back River, as shown in the sketch.

The estimates for damages to property on Hutchinson's Island have not yet been made by the commissioners appointed for that purpose, but the question has been worked down to a point within the proper control of the government. The city will supply a quantity of land equal to that cut off, which leaves the actual damages to be paid to depend upon the cost of removing the mills, wharves, &c., and if too large an allowance is asked for this change, the government can come forward and make the removals of wharves, &c., after the line has been dredged. Of course the removal of mills, buildings., &c, will have to take place before the dredging is begun. I do not suppose the aggregate damages can exceed $100,000, and should not, if judiciously ascertained, reach $75,000.

ESTIMATES.

For harbor improvements, including land damages—say land and property damages	$100,000
Dredging bottom of harbor and widening river at the city	95,000
Completing improvements at the "Wrecks" Shoal and deepening the channel to 17 feet	35,000
Raising Cross-Tides Dam properly	10,000
	240,000
Improvements below Elba Island	350,000
Total	590,000

The improvements are estimated upon the project approved by the Board of Engineers in 1879 for a water-way of 600 feet.

The universal desire of the business community here is for a channel of greater width, as much as 800 feet, in consequence of the manifest necessities for the future business to be done here in the transshipment of produce and merchandise, foreign and domestic.

I will go to Charleston as soon as my annual reports are completed, and we can then discuss the subject embraced in this report.

I am, very respectfully, your obedient servant,

S. L. Freemont,
Assistant United States Engineer.

Capt. B. D. Greene.

J 5.

IMPROVEMENT OF SAVANNAH RIVER, GEORGIA, BETWEEN THE CITIES OF AUGUSTA AND SAVANNAH.

By act approved March 3, 1881, the sum of $15,000 was appropriated for improving Savannah River, Georgia, referring to that portion of the river extending from Augusta to the head of Hutchinson's Island, about 4 miles above the city of Savannah. It was the first appropriation ever made by Congress for that purpose.

This portion of the river was examined under my direction in September and October, 1880, and my report thereon was forwarded to the Chief of Engineers on December 22, 1880.

The distance between the cities of Savannah and Augusta is 108 miles in a straight line, and by water 248 miles.

For a greater portion of the year, this portion of the stream is navigable for steamboats drawing from 4 to 5 feet, but during the dry season in autumn the water is very low at various places, with depths of only 2 to 3 feet on some of the shoals, and boats usually have to discharge and receive their cargoes at some point below Augusta.

The principal obstructions to navigation are shoals or bars of sand, and snags of floating timber. Pile obstructions were found at two places.

PROJECT OF IMPROVEMENT.

The project for improving the river as recommended in my report of December 22, 1880, comprises the following works:

1. Narrowing the river by low wing-dams where excessive widths produce or maintain shoals.
2. Aiding the accumulation of silt between the wing-dams by low and light hurdle traverses.
3. Protecting the banks, where needed, by thin, flexible brush mattresses, weighted with stone, or in some other suitable manner.
4. Cutting off some projecting points of land.

5. Removing existing pile obstructions.
6. Removing snags, floating timber, and overhanging trees.
7. Aiding the formation of the low-water channel in a few localities by dredging.

The object of these works is to procure a low-river navigable depth of 5 feet, and their cost is estimated at $91,000.

The obstructions formed by sand-bars, that should be removed, are all within 100 miles of Augusta by river. The worst shoals exist just below the city of Augusta, and are known as Gardner's Bar and Course's Bar. Snags and floating trees are scattered along the whole distance from near Augusta to near Savannah.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1882.

A short time previous to June 30, 1881, measures were taken to begin work by constructing a suitable snag-boat to be used in removing snags, piles, trees, &c.

It had been expected that such a boat might be purchased and fitted up for work with second-hand, but serviceable machinery and boiler, at a cost of about $7,500, based upon an offer made by a party in Wilmington, N. C., who subsequently refused to execute the necessary contract.

It was then decided to build and fit up a new boat with new machinery and boiler. The cost of the outfit was unavoidably and greatly increased thereby, and especially as there was a rise in the price of labor and material during the year. The aggregate cost of the boat was, however, still less than estimated for in the project submitted with my report of December 22, 1880.

The snag-boat was ready for service in February, 1882. It is thoroughly well built, suitably fitted up, and furnished with ample motive-power, derrick, capstan, and capstan engine, &c.

Since this boat can be used to advantage at various points of the river, below the city of Savannah, a portion of its cost, amounting to $3,000, was charged to the improvement of Savannah River and Harbor, by department letter, dated February 23, 1882. A further sum of $5,000 was, by authority of the Chief of Engineers, charged to the improvement of Altamaha River, Georgia, where the boat is intended to be extensively used.

The expenses incurred in constructing the boat were so great that comparatively little work could be performed with the balance of the appropriation left on hand.

When in commission the expenses of running the boat amount to $1,200 per month. The snag-boat went to work on the river during the latter part of February, 1882, and continued until April 7, 1882, when she was laid up at Savannah, the appropriation having been exhausted. She operated on a reach of about 60 miles in length, from the "obstructions," or rows of piles driven during the late war, between Hack's Bar and Brigham's Bar, about 70 miles below Augusta, and Briar's Creek, about 130 miles below that city. A number of piles, snags, drift-logs, and overhanging trees were removed. They are enumerated in the accompanying report of my assistant, Capt. B. D. Greene, Corps of Engineers.

Owing to the limited time during which operations could be carried on, no material change in the condition of the river could be produced. The boat proved to be well fitted for the work.

OPERATIONS CONTEMPLATED DURING THE PRESENT FISCAL YEAR.

With such funds as may become available it is proposed to continue the work of removing snags, drift-logs, overhanging trees, &c.; in building wing-dams to contract the river where excessive widths cause and maintain shoals; and, by other operations, amending first those portions of the river most urgently requiring improvement.

Augusta is an important commercial town in the State of Georgia. Its population in 1880 was 23,023.

A large area of country is directly interested in securing greater depth in the navigable channel during low stages of the river, from Augusta to tide-water.

It is recommended that a liberal appropriation for this work should be made for the next fiscal year.

This work is located in the collection district of Savannah, Ga.

Savannah is the nearest port of entry. Amount of import duties, tonnage dues, &c., collected in 1881, $393,265.84.

The report of Capt. B. D. Greene, Corps of Engineers, is transmitted herewith:

Money statement.

July 1, 1881, amount available	$15,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	14,924 82
July 1, 1882, amount available	75 18
Amount appropriated by act passed August 2, 1882	25,000 00
Amount available for fiscal year ending June 30, 1883	25,075 18
Amount (estimated) required for completion of existing project	51,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	51,000 00

REPORT OF CAPT. B. D. GREENE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., July 1, 1882.

COLONEL: I have the honor to submit the following report upon the work of improvement of Savannah River, Georgia, for the fiscal year ending June 30, 1882.

As the first thing to be done on this part of the river was to remove the snags and logs that were in the channel-way, and pull out of the way the leaning trees that interfered with the navigation of the river, it became necessary to expend a good share of the appropriation in the construction of a boat for the above purposes. This boat—named the Toccoa—was completed in February, and at once went up the river. She was engaged during the month of March in removing snags, piles, trees, &c., from the channel for a length of about 60 miles, at the worst points, beginning at the "Obstructions" and working down.

These "obstructions" consist of rows of piling driven there to close the river during the war. They are at a distance of 180 miles above Savannah.

During the time the boat was out there were removed from the channel 91 logs and 53 snags; 141 overhanging trees were cut and pulled back; 3 trash piles cleared up.

The failure of the appropriation available rendered it necessary to lay up the boat until a new appropriation is made.

The time employed showed the boat to be well-fitted for the purpose, and it may be expected another season that she will do a great deal for the improvement of the rivers in this district.

Very respectfully, your obedient servant,

BENJ. D. GREENE,
Captain of Engineers.

Lieut. Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

J 6.

IMPROVEMENT OF SAVANNAH RIVER ABOVE AUGUSTA, GEORGIA.

By act approved March 3, 1881, the sum of $8,000 was appropriated for improving Savannah River above Augusta, Ga. The sum of $16,000 had been previously appropriated by act approved June 14, 1880, which was the first appropriation ever made by Congress for this work.

This portion of the Savannah River was examined in November and December, 1878, and the report thereon printed in Appendix I 2, Annual Report of the Chief of Engineers for 1879.

It was stated in that report that, until a thorough examination could be made above Trotter's Shoal, 64 miles above Augusta, any money that might be appropriated should be expended upon that portion of the river below that shoal.

Two estimates were submitted, viz:

1. Cost of improving the river for pole-boat channel, 3 by 30 feet, from Augusta to Trotter's Shoal, 64 miles	$45,000
2. Cost of steamboat channel, 3 by 90 feet, on same route	124,000

OPERATIONS PRIOR TO JUNE 30, 1881.

For the purpose of applying the sum of $16,000 first appropriated for this improvement, a contract had been entered into with Messrs. Anderson and Blaisdell, of Boston, Mass., on November 26, 1880.

The beginning of the operations was greatly delayed by the unusually long-continued high stage of the river, and work could not be commenced until June, 1881. At the end of that month 125 cubic yards of rock and 27 cubic yards of gravel had been removed from ledges and shoals, and 37 cubic yards of rock from an old dam. A number of wing-dams for confining the currents were built, containing an aggregate of 658 cubic yards of broken rock.

These improvements were made at Little Rapid Gap, Steven's Creek Falls, and Big Rapid Gap, all within 8 miles of the city of Augusta.

OPERATIONS DURING THE FISCAL YEAR JUST CLOSED.

Operations were continued during the first part of the last fiscal year under the contract with Anderson and Blaisdell, and concluded on September 2, 1881.

Previous to that date I had recommended that work should be further continued with the $8,000 appropriated March 3, 1881, by purchasing material and hiring the labor from the contractors, who had their plant and force of experienced laborers on the ground. This plan was approved in department letter dated August 18, 1881, and work was carried on without interruption, and at the same prices as previously paid.

Operations finally ceased on September 23, 1881, when the available funds were exhausted.

From July 1, 1881, to the time when operations had to be suspended, 3,365 cubic yards of rock and 35 cubic yards of gravel had been excavated, and 1,800 cubic yards of riprap dams were built.

The work was done at numerous places between Steven's Creek Falls, 8 miles from Augusta, and Trotter's Shoal, 64 miles from Augusta. At many points of this reach the work remains incomplete, especially in the section from near Pine Log Falls to the vicinity of Long Shoal, at distances of 13 and 33 miles, respectively, from Augusta.

SUMMARY OF WORK DONE FROM THE BEGINNING TO THE END OF OPERATIONS.

The aggregate amount of work done on this improvement under the contract of November 26, 1880, and under the subsequent arrangement referred to, consisted in the removal, chiefly by blasting, of 3,490 cubic yards of rock, the excavation of 62 cubic yards of gravel from bars and of 37 cubic yards of rock from an old dam, and in the construction of wing-dams containing a total of 2,458 cubic yards of broken rock.

From an examination of the river made after operations were suspended it appears that the work executed had undoubtedly improved the channel, although it must be remarked that the pole-boats going down-stream are more benefited thereby than those going up, since the velocity of the currents through the improved channels has been somewhat increased.

Operations will be continued during the fiscal year just commenced, if an appropriation is made for this work.

This work is located in the collection district of Savannah, Ga. Savannah is the nearest port of entry.

Amount of import duties, tonnage dues, &c., collected in 1881, $393,265.84.

The report of Capt. B. D. Greene, Corps of Engineers, is appended.

Money statement.

July 1, 1881, amount available	$21,115 98
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	20,868 74
July 1, 1882, amount available	247 24
Amount appropriated by act passed August 2, 1882	15,000 00
Amount available for fiscal year ending June 30, 1883	15,247 24

REPORT OF CAPT. B. D. GREENE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., July 1, 1882.

COLONEL: I have the honor to submit the following report upon the improvement of Savannah River above Augusta, Ga., for the fiscal year ending June 30, 1882.

Work was commenced upon this portion of the river in the latter part of June and completed about September 20, 1881. In this time some 3,000 cubic yards of rock were removed from the low-water channel at a great many localities between Augusta and Trotter's Shoal.

Dams were built in several places for the purpose of concentrating the flow, either to increase the depth over a ledge of rock or remove sand or gravel bars.

The work that was done probably benefited the channel considerably, but the slope of the stream is so great that the limit was soon reached beyond which the plan of work would do more harm than good.

A plan suited to the case would involve the expenditure of some millions probably, and does not seem demanded by the present or prospective needs of the region through which the river flows.

Under these circumstances, no further appropriation, in my opinion, should be made for this work.

Very respectfully, your obedient servant,

BENJ. D. GREENE,
Captain of Engineers.

Lieut. Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

J 7.

IMPROVEMENT OF ALTAMAHA RIVER, GEORGIA.

By the act approved March 3, 1881, the sum of $5,000 was appropriated for improving Altamaha River, Georgia, being the first appropriation made by Congress for the work.

The Altamaha River, the most important of the rivers contained entirely within the State of Georgia, is formed by the confluence of the Oconee and Ocmulgee. It has a southeasterly course, and empties into the Atlantic Ocean through Altamaha Sound, below the town of Darien. Its total length is about 155 miles.

The river was examined under my direction in October, 1880, as provided for by section 2 of the river and harbor act approved June 14, 1880. My report is printed in Appendix J 9 of the Annual Report of the Chief of Engineers for 1881.

The chief obstructions to navigation consist in rock ledges running nearly across the stream, sand bars, and snags. An old wreck in the upper portion of the river, and piles driven during the late civil war, at two places lower down, also more or less impede the passage of vessels.

PROJECT OF IMPROVEMENT.

The estimate submitted with my report of the examination provides for the removal of about 10,500 cubic yards of rock, and of the old wreck and the pile obstructions, as well as of several thousand snags, all in the fresh-water reaches of the river; also for dredging 8,000 cubic yards of material near to and above Darien.

The localities where sand bars occur, and which would likewise require improvement, were not included, since it will be necessary to have them instrumentally surveyed before a plan of improvement can be devised. The partial project submitted contemplated the establishment of a channel navigable for boats of 3 feet draught.

The cost was estimated as follows:

For a channel 200 feet wide by 3 feet deep	$61,000
For a channel 80 feet wide by 3 feet deep	30,000

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1882.

The sum of $5,000 available for beginning the work of improving Altamaha River, on July 1, 1881, was entirely expended in providing a snag-boat suitable for service on this river. This snag-boat was completed in February, 1882. As she is designed to be employed also on the Savannah River, below Augusta, Ga., the balance of the cost of building and equipping the boat was paid out of the appropriations made for improving Savannah River and Savannah Harbor.

OPERATIONS CONTEMPLATED DURING THE FISCAL YEAR JUST COMMENCED.

It is proposed to expend such money as shall become available in removing snags of the worst character; piles driven in the bed of the river at two places, known as the "Confederate Obstructions," and, if possible, some of the most objectionable rock, bars, or reefs. An instrumental survey will be made of some sections of the river where special works seem to be required.

The work on the Altamaha will probably have to be done by hired labor, it being of a character that cannot well be described in specifications.

As to the benefits that may be expected to follow the completion of this improvement, I beg leave to refer to the remarks made in my report of November 27, 1880. No new data have been received since then.

This work is located in the collection district of Brunswick, Ga. Darien is the nearest port of entry. The total collections of the custom-house at Darien during the calendar year 1881 were $18,980.02.

A table of commercial statistics furnished by the collector of the port of Darien accompanies this report.

Money statement.

July 1, 1881, amount available	$5,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	4,993 90
July 1, 1882, amount available	6 10
Amount appropriated by act passed August 2, 1882	15,000 00
Amount available for fiscal year ending June 30, 1883	15,006 10
Amount (estimated) required for completion of existing project	40,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	40,000 00

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels at Darien, Ga., from January 1, 1880, *to December* 31, 1881.

VESSELS ARRIVED.

Year.	Coastwise.			American vessels from foreign ports.			Foreign vessels from foreign ports.			Total.		
	Number of vessels.	Tonnage.	Crew.	Number of vessels.	Tonnage.	Crew.	Number of vessels.	Tonnage.	Crew.	Number of vessels.	Tonnage.	Crew.
1880	66	21,539	489	1	668	13	134	68,072	1,608	201	90,279	2,110
1881	101	40.619	849	3	1,220	29	162	84,456	1,991	266	126,295	2,869

VESSELS CLEARED.

Year.	Coastwise.			American vessels for foreign ports.			Foreign vessels for foreign ports.			Total.		
	Number of vessels.	Tonnage.	Crew.	Number of vessels.	Tonnage.	Crew.	Number of vessels.	Tonnage.	Crew.	Number of vessels.	Tonnage.	Crew.
1880	55	17,076	393	7	3,589	72	168	84,172	2,016	220	104,837	2,481
1881	80	28,492	617	8	3,120	70	184	95,353	2,164	272	126,965	2,851

Year.	Value of exports.	Value of imports.	Duties collected.
1880	$1,021,904	$5,600	$16,806 72
1881	1,137,496	3,356	18,980 02

J 8.

IMPROVEMENT OF BRUNSWICK HARBOR, GEORGIA.

During the fiscal year ending June 30, 1882, operations were carried on in general conformity to the project of improvement first suggested in my report of April 29, 1876, modified as described in my annual report for the fiscal year ending June 30, 1880.

Previous to the beginning of operations under the approved project, an appropriation of $10,000 was made by Congress in 1836, and expended for removing a shoal in the same locality where improvements are now being made.

The project under which work has been recently prosecuted provides for the construction of a jetty projecting from the most easterly point of Buzzard's Island, located approximately parallel to, and about 1,000 feet distant from the opposite shore, for the purpose of contracting the water-way, and concentrating the currents; also, for more or less dredging, where it is necessary to aid the action of the currents in deepening the channel.

The object of these operations is to establish and maintain a ship-channel of 15 feet depth at mean low-water through the shoal situated about 1 mile below the city of Brunswick where, heretofore there existed a navigable low-water depth of only 9 feet. The cost of this project was estimated at $73,187.50. In the project no estimates were included for works at the upper end of Buzzard's Island, or elsewhere, that eventually might be needed for the purpose of augmenting the ebb-flow in the branch under improvement. These matters were held in abeyance, for future consideration.

RECAPITULATION OF OPERATIONS PRIOR TO JUNE 30, 1881.

From the time the present project was adopted to June 30, 1881, the following work was executed:

A hydrographic survey of the whole length of East River, on which the city of Brunswick is situated; preparations of working plans, and beginning work on the crib-jetty, and dredging. The crib-work was done as described in my annual reports of 1880 and 1881, and under a contract with J. Brady, dated January 30, 1880.

Dredging operations were carried on under a contract made with J. E. Walter, dated February 28, 1880.

Up to June 30, 1881, thirty-seven cribs had been sunk in position. Fourteen of these, of an aggregate length of 310 feet, formed the return face of the jetty, at a right-angle to the shore line, with an extension to high-water line of about 35 feet length and 24 feet width, formed by a log mattress loaded with riprap stone.

The balance of the cribs, twenty-three in number, had been placed on the main line, and occupied an aggregate length of 475 feet. These cribs are kept some feet below low-water line; they are filled with some brush, and with material obtained by dredging, and are topped off with broken stone.

During the same period a total amount of 36,002 cubic yards was removed by dredging a rudimentary channel through the shoal portion of the approach to the harbor and parallel to the main line of the jetty.

Two appropriations, aggregating $30,000, had become available, but, owing to the slow progress made by both contractors, the first appropriation of $20,000, by act approved March 3, 1879, had not been exhausted at the end of June, 1881, while the second appropriation of $10,000 remained untouched.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1882.

During the fiscal year just closed, the main line of the jetty was further extended by an additional length of 1,319 feet.

About 305 feet of this length is formed by twelve palmetto cribs, resting on grillages of pine logs, placed under the Brady contract, built and filled like those previously sunk, and described in the Annual Report of 1881. The Brady contract was completed in January, 1882.

The balance of work done on the main line of the jetty, during the past fiscal year, comprising a length of 1,014 feet, consisted in putting down double raft mattresses formed of two tiers of pine logs averaging 12 inches in diameter, with 10-inch binders between the upper and lower tiers, drift bolted to the logs. The lower tier varied from 30 to 34 feet in width; the logs of the upper tier were 10 feet shorter than those of the lower tier. These mattresses, which measured about 3 feet in height, were covered with broken stone to a thickness of about 12 inches. Twenty of such mattresses were sunk; half of their number received in addition a compact layer of brush 12 inches thick and 12 feet wide. This work was done under a contract entered into on May 2, 1881, with Messrs. Anderson and Blaisdell, and was concluded in April, 1882, from exhaustion of funds.

The aggregate length of the jetty amounts at present to 2,104 feet, exclusive of the portion 35 feet long, on shore, above the low-water line. The length of the return face is 310 feet; the main line, as far as now built, measures, therefore, 1,794 linear feet, of which a length of 780 feet is occupied by palmetto cribs, and the balance by double raft mattresses.

The direction of the main line of the jetty was originally about south 14° 30′ east, for a length of 650 feet, from the point of junction with the return face; in September, 1881, it was slightly modified, and the line has since that time followed a direction south 12° east. This change was made with a view of improving the direction of the proposed bulkhead line of the Brunswick shore, which is designed to be located at a distance of about 850 feet from the axis of the jetty.

The crib portion of the jetty is placed in comparatively deep water, varying from 12 to 17 feet, at low-tide; the double raft mattresses occupy shoaler water.

During the fiscal year just closed 16,016 cubic yards of material were dredged on a line parallel to the jetty, and about 240 yards east of it. One cut was made to a bottom width of about 20 feet, a length of over 3,400 feet, and to a low-water depth of 15 feet, and it extended to deep water, about opposite Brandy Point, the southeasterly end of Buzzard's Island. Of the total amount dredged 4,000 cubic yards were removed under the contract made with J. E. Walter on February 28, 1880, and the balance, or 12,016 cubic yards, was taken out, at the price of 27 cents per cubic yard, under another contract entered into with the same party on July 16, 1881.

Dredging operations were suspended in March, 1882, the available funds having been expended.

Since the beginning of operations a total of 52,018 cubic yards has been removed by dredging. This material was excavated on 2 lines of cutting, each line about 4,400 feet in length, 20 to 25 feet in width at bottom, and cut to a low-water depth of 15 feet; and in two adjoining unfinished lines, each of the same bottom width of 20 to 25 feet, but only 1,350 feet in length, and cut to a low-water depth of 12 feet.

These four lines of dredging all commence at a point a little above the angle formed by the jetty with its return face.

Work during the fiscal year ending June 30, 1882, was carried on by means of the balance of $20,240.24, available on July 1, 1881, as stated in my annual report for 1881, which amount included the sum of $5,000, appropriated by act approved March 3, 1881. In the beginning of April, 1882, the funds were exhausted, and operations had to be suspended.

CONDITION OF THE WORK.

The jetty cribs, as well as the double-raft mattresses, stand well. A remarkable accumulation of barnacles and oyster shells is observed to be going on upon the logs of the cribs, and upon the riprap stone covering their tops. This process is especially noticed on the cribs of the return face, which were sunk first. This species of coating, it is thought, will contribute to insure the permanency of the work. It seems that even now, in its unfinished state, the jetty has some effect in concentrating the waters of the ebb-flow in the narrowed water-way.

The depth of 15 feet at low-water, obtained by dredging in the through-cuts, has been reduced only about 1 foot by shoaling, except at a few spots, where 13 feet depth is found. The general low-water depth on these lines before dredging began amounted to about 9 feet.

The shoalest water on the dredged lines shows an increase of about 4 feet in depth. The maintenance of such depth is ascribed to some increase in the strength of the currents of the ebb-flow, due to the jetty.

Since the survey was made under my direction, in August, 1879, the upper entrance of the East River branch, on which the town of Brunswick is located, which was then found to be characterized by shallow depths of water, appears to have shoaled still more. Consequently, the entrance of the waters of Turtle River, during the ebb-tide, is becoming more obstructed, and the effects of the jetty, now partly built, are proportionally weakened. Some works at the point indicated are evidently needed. That they would be necessary eventually was pointed out in my annual report for the fiscal year ending June 30, 1880.

Complaint has recently been made by the mayor of Brunswick, and by members of the mercantile community of that place, in regard to the bar existing near the north end of the city, at the confluence of Academy Creek and East or Brunswick River.

Academy Creek is an arm of the East River. It has a tortuous course of about 4 miles length; its head is in the marshes, only a short distance from Turtle River. The Brunswick and Altamaha Canal enters it about three-quarters of a mile from its mouth.

The low-water depth on the shoal complained of is from 6 to 7 feet, and it is claimed that by increasing the depth to 10 feet great benefits would accrue to the shipping business of the upper part of the city of Brunswick, and the citizens requested that an appropriation of about $1,000 be made by Congress for dredging at this place. This shoal is probably due to the circumstance that the ebb currents flowing from Academy Creek meet those of Brunswick River at about a right angle, causing a diminution of velocity and scouring power. The strongest currents are deflected to the opposite side, near Buzzard's Island, where deep water is found. Dredging alone will therefore afford only temporary relief, as the operation will not remove the cause of shoaling. A stronger influx of water into Brunswick River from Turtle River during ebb-tide, through suitable works at the head of Buzzard's Island, will tend to lower the shoal. Additional depth would most likely be obtained by closing the mouth of Academy Creek, which would naturally operate to throw the waters of the ebb flow of Brunswick River into the concave bend where the shoal is located, and thereby wash it off. This would probably be the safest plan; but an objection to it would be that the canal mentioned above would be cut off from connection with Brunswick River.

Assistant Fremont suggests as a remedy to cut through the narrow strip of intervening marsh-land, from Turtle River to the head of Academy Creek, to produce stronger ebb currents through the latter, which would lower the bar at the mouth. He estimates the cost of such a cut at $4,000.

OPERATIONS CONTEMPLATED DURING THE PRESENT FISCAL YEAR.

With any appropriation that may become available it is proposed to continue work on the jetty, and widen and deepen the ship channel by dredging.

The jetty will be further extended down stream by means of sinking double-raft mattresses, covered with broken stone, in the manner already described.

Dredging in the channel to be improved will be resumed. It is also intended to expend a small part of the appropriation in making a survey of the upper part of East River, and of an adjoining portion of Turtle River, for the purpose of designing works of improvements in that locality, as already referred to.

Brunswick is still a small, but thriving, and, of late, rapidly growing place. Its harbor has ample anchorage for large numbers of heavy-draught vessels. The minimum depth across the outer bar is from 16 to 17 feet at mean low-water, with a rise and fall of tides of nearly 7 feet. The principal drawback to a more rapid development of marine commerce consists in the shoal, the improvement of which has lately been begun. The city is the seaboard terminus of two lines of railroad, extending far into the interior of the country, capable of bringing here for shipment a large amount of the products of the Western States. It is understood that grain-elevators and cotton-presses are soon to be constructed at this place.

As the upper reach of Turtle River, above Buzzard's Island, and therefore above the upper end of the branch on which the town of Brunswick is located, is both deep and capacious, it is not improbable that wharves and railroad depots will be established at that point at a distance of about 5 miles above the town, in order to avoid the shallow navigation in the branch, where the jetty is in progress.

No further particulars or statistics have been received in addition to those briefly stated in my last annual report.

An early completion of this improvement seems to be very desirable.

This improvement is located in the collection district of Brunswick, Ga. Brunswick is the nearest port of entry.

Import duties and other dues collected during the last fiscal year, $29,305.30.

For carrying out the present plan of improvement the following appropriations have been made:

By act of Congress approved March 3, 1879	$20,000
By act of Congress approved June 14, 1880	10,000
By act of Congress approved March 3, 1881	5,000
Total	35,000

The expenditures to June 30, 1882, amounted to	34,998 53
The estimated cost of the improvement is	73,187 50

A revised project, with estimates of cost, will be prepared during the fiscal year just commenced.

The following papers accompany this report:

1. Chart of Brunswick Harbor, showing location of works and progress made to June 30, 1882.
2. Commercial statistics by the collector of customs at Brunswick.

Money statement.

July 1, 1881, amount available	$20,240 24
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	20,238 77
July 1, 1882, amount available	1 47
Amount appropriated by act passed August 2, 1882	25,000 00
Amount available for fiscal year ending June 30, 1883	25,001 47
Amount (estimated) required for completion of existing project	13,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	13,000 00

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels at Brunswick, Ga., from January, 1878, to December 31, 1881.

VESSELS ARRIVED.

Years.	Coastwise.			American vessels from foreign ports.			Foreign vessels from foreign ports.			Total.		
	Number of vessels.	Tonnage.	Crew.	Number of vessels.	Tonnage.	Crew.	Number of vessels.	Tonnage.	Crew.	Number of vessels.	Tonnage.	Crew.
1878	116	32,584	850	36	10,218	270	41	19,008	493	193	61,810	1,613
1879	148	44,397	1,090	33	8,235	232	40	17,589	468	221	70,221	1,790
1880	271	77,656	1,892	36	11,219	317	39	14,996	432	346	103,871	2,641
1881	279	100,451	2,239	13	4,174	98	63	30,279	751	355	134,904	3,088

VESSELS CLEARED.

Years.	Coastwise.			American vessels for foreign ports.			Foreign vessels for foreign ports.			Total.		
	Number of vessels.	Tonnage.	Crew.	Number of vessels.	Tonnage.	Crew.	Number of vessels.	Tonnage.	Crew.	Number of vessels.	Tonnage.	Crew.
1878	124	32, 767	874	28	9, 231	236	49	21, 268	550	201	63, 266	1, 660
1879	157	42, 345	1, 116	21	7, 172	172	47	21, 730	555	225	71, 247	1, 843
1880	270	78, 913	2, 010	14	5, 010	115	48	19, 977	550	332	103, 900	2, 675
1881	252	82, 155	1, 732	17	7, 218	156	87	42, 659	1, 014	356	132, 032	2, 902

Years.	Value of exports.	Value of imports.	Total collections.
1878	$1, 372, 842	$400	$4, 560 97
1879	1, 394, 401	3, 197	5, 644 33
1880	1, 702, 570	8, 908	17, 723 24
1881	2, 230, 000	4, 377	29, 305 30

J 9.

IMPROVEMENT OF ENTRANCE TO CUMBERLAND SOUND, FLORIDA AND GEORGIA.

During the fiscal year ending June 30, 1882, operations for improving the entrance to Cumberland Sound, Florida and Georgia, were continued in conformity to the project submitted with my report of June 30, 1879, printed as Appendix I 8, Annual Report of the Chief of Engineers for 1879.

The first appropriation ever made by Congress for this improvement, amounting to $30,000, was provided by act approved June 14, 1880. A second appropriation to the amount of $100,000 was made by act approved March 3, 1881.

The plan of improvement comprised the construction of two low jetties, composed of riprap stone, resting on a foundation mattress of logs, or logs and brush, starting respectively from the shores on opposite sides of the entrance and extending seaward across the bar, upon lines so directed that the outer ends will be parallel to each other, and from 3,000 to 2,500 feet apart, or such distance as may hereafter be deemed necessary.

Two low jetties, reaching entirely across the bar, would be expected to maintain a low-water channel not less than 20 to 21 feet deep. Greater depth could be secured by carrying the jetties to higher levels. The estimated cost of the work is $2,071,023.

With a single long jetty placed on the north shoal, and a spur jetty on the south side, a low-water channel 16 to 17 feet deep would be maintained. In this case the work would cost $1,000,000.

OPERATIONS PREVIOUS TO JUNE 30, 1881.

Actual work was begun on the north jetty in June, 1881, under the contract entered into with Messrs. Lara, Ross & Co., on September 4, 1880.

The land end of the jetty is located on the east shore of Cumberland Island, and about 2,000 feet from its southern end. The work was started on a range bearing south 63½° east, which direction was to be followed until Cumberland Channel was passed.

Up to June 30, 1881, the total length of apron foundation laid was 276 feet, from 25 to 35 feet in width, composed of a mattress of logs and brush, about 19 inches thick, overlaid with about 313 cubic yards of riprap stone.

No work was done on the south jetty prior to June 30, 1881.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1882.

On July 1, 1881, the sum of $128,922.98 was available for continuing the work.

During the last fiscal year the foundation course of the north jetty was further extended, and a second course placed upon a part of its length. Work was also commenced on the south jetty. The entrance to Cumberland Sound was partially resurveyed.

Operations were carried on under two contracts. Messrs. Lara, Ross, & Co., under their contract of September 4, 1880, employed for some months, Messrs. Blaisdell & Greely as their agents, but towards the close of the fiscal year they took the work in their own hands.

As stated in my last annual report the contract for work to be executed by means of the second appropriation, amounting to $100,000, was to be awarded to Mr. A. Blaisdell, one of the agents just named, provided he made good progress on the north jetty, where he was then engaged. His progress during the first three months of the fiscal year was very unsatisfactory, however, and no reasonable hope could be entertained that he would be able to do better in future.

By direction of the Chief of Engineers, new proposals for doing the work were called on October 11, 1881. The specifications provided that the mattress should consist simply of a raft of round logs, not less than 12 inches in average diameter, and not less than 9 inches in diameter at the small end, placed in close contact, side by side, at right angles to the line of jetty, and firmly held there by transverse pole binders spiked or bolted to them. The binders were to be smaller logs or poles, not less than 4 inches thick at the small end, and placed not more than 8 feet apart. Those on the outside were to be close to the end of the logs.

It was optional with the engineer in charge to have a layer of live hard-wood brush, 9 feet wide and 6 inches thick, placed on the opposite edges of the mattress, extending about 1 foot beyond the ends of the logs. The brush was to be firmly held down to the mattress by pole binders. A layer of stone, not exceeding one or two feet in thickness, was to be placed on the mattress.

The bidders were required to name a price per square yard for mattresses in the work, a price per square yard for the layer of brush, and a price per cubic yard for stone in the work. Mr. A. M. Newton, of New York City, was found to be the lowest bidder. The prices named by him were, 97 cents per square yard for mattresses, 8 cents per square yard for brush, and $3.85 per cubic yard for stone. These terms were considered to be reasonable, and a contract was concluded with Mr. Newton on November 26, 1881. He commenced work soon after, and made satisfactory progress.

North jetty.—The apron foundation was continued on the first range to a point 2,200 feet from shore. Cumberland Channel was crossed in this reach. The greatest low-water depth met with was 13 feet, at a distance of 1,250 feet from high-water line on shore. The work was then extended on a line bearing about south 80 degrees east, which direction will bring it to the North Breakers, north of Pelican Shoal.

The nearest distance of the second range line, from the shore of Amelia Island, near Fort Clinch, is about 1 mile. At the initial point of the new line, the depth is about 7 feet at low-tide; farther on the water is very shallow at some places, alternating with deeper portions, and varying from less than 1 foot to 10 feet at low-water. It seems that scouring currents, which produce greater depths, are developed ahead of the work as it progresses.

Since February the mattresses of the bottom course have been generally laid to lap from 8 to 10 feet, as far as practicable, in order that no spaces shall be left between them, which, in endeavoring to place the mats end to end, were often found to be unavoidable, in consequence of the rough water and troublesome currents here prevailing. From the same cause several mats were unavoidably placed more or less out of range, and the uncovered spaces had to be filled by additional work. Several lighters were sunk while at work, and the contractor's tug-boat grounded and was badly damaged.

During the fiscal year now closed, the bottom course of the north jetty was extended 7,196 feet. The widths of the log and brush mattresses ranged from 35 to 52 feet, and their thickness, or height, exclusive of stone, from 19 to 21¾ inches.

A second course of mattresses of similar thickness, from 20 to 25 feet wide and aggregating 1,366 feet in length, was placed upon the apron at the deeper portions of the Cumberland Channel, on the first range. There were 10,824 cubic yards of stone deposited on the work during the year.

South jetty.—Work was begun here in May last. The starting point of the jetty, on the eastern or seaward shore of Amelia Island, is situated about 5,700 feet from Fort Clinch, on a line bearing south 78½° east from that place. Its shortest distance from the second range line of the north jetty produced is about 5,600 feet. It was the intention to begin at a point about 1,000 feet farther south, but the water was found to be too rough and shallow, and the line too difficult of access to render it practicable. The first range as adopted runs due east, and it is proposed to maintain that course for a length of about 4,000 feet.

On June 30, 1882, the apron foundation of the south jetty had reached a point 1,316 feet from shore. The greatest depth in which the work was laid was about 5 feet at low-water. The mattresses are from 40 to 50 feet wide and about 21 inches thick. An aggregate of 2,443 cubic yards of riprap stone was deposited upon the mattresses, averaging about 1 foot of stone in thickness upon the work.

SUMMARY OF WORK DONE FROM THE BEGINNING OF OPERATIONS TO JUNE 30, 1882.

North jetty.—The apron foundation of the north jetty was laid for a length of 7,372 feet. The width of the mattress varies from 25 to 52 feet. A second course of mats was laid for a length of 1,366 feet, and from 20 to 25 feet wide.

Riprap stone was distributed over the work, aggregating 11,137 cubic yards.

South jetty.—The apron foundation has reached a length of 1,316 feet. It is composed of log and brush mattresses from 40 to 50 feet in width, and is covered with 2,443 cubic yards of stone.

CONDITION OF THE WORK.

No noteworthy changes in the general condition of either the north jetty or south jetty, as far as built, are to be recorded, but some facts have been observed which should be mentioned.

In Cumberland Channel the strength of the currents seems to have rather increased, and both above and below the line, where the north jetty crosses the channel, there is now deeper water than formerly. The work has not settled, however, and it is well covered with sand. Additional height must be gained here as soon as funds shall have become available.

Beyond Cumberland Channel in the shallow water, in which the easterly portion of the north jetty is placed, a number of the mats are near the surface of the water at low-tide, some even above that level. Near the period of low-tide strong currents cross the work at all the lower places.

At the higher stages of the tide, the transverse currents increase in strength, and finally sweep across the crest of the work, on its entire length. They also pass around the outer end of the rudimentary jetty, and produce greater depths ahead of it.

If operations have to be suspended for a considerable length of time, or cannot be carried on upon a sufficiently large scale, it may be expected that this process of scouring and deepening will be inconveniently developed, to such a degree probably as to add very considerably to the cost of the work. These shoal water currents also prevent the accumulation of drift sand upon the mattresses, and therefore expose the logs more or less to the attacks of the teredo. Riprap stone should be therefore liberally distributed over the foundation apron to protect it and to bring the crest of the work to a greater height. Parallel currents will probably be created as the jetty rises higher, and substantial spurs will have to be built to break up these currents or keep them at a safe distance from the main line.

The condition of the beach in the vicinity of the shore ends of both jetties is satisfactory. Near the north jetty the low-water line has advanced toward Cumberland Channel for a distance of 350 feet, and the foundation course of the jetty is covered with sand to that extent.

At the south end of Cumberland Island some washing off is noted, both the high-water and low-water line having receded about 60 feet.

At the site of the south jetty, the high-water line has advanced seaward about 350 feet since the survey of 1879 was made.

OPERATIONS CONTEMPLATED DURING THE PRESENT FISCAL YEAR.

With the small balance on hand, July 1, 1882, and with such additional funds as may be appropriated by Congress, it is proposed to extend the apron foundation of both jetties, and raise the work to a greater height at several places. The work will be continued substantially in the same manner and by the same methods as heretofore.

In my last annual report, printed as Appendix I 11 of the Annual Report of the Chief of Engineers for 1881, I offered a few remarks upon the commerce and navigation of the harbors of Fernandina and Saint Mary's, to which I have nothing new to add at present. It may be said, however, that the work of improving the entrance to Cumberland Sound having been now fairly begun, it seems desirable that it should be pushed forward with vigor. With large appropriations, which imply favorable contracts with responsible and efficient parties, the ground eventually to be occupied by the jetties can be covered more rapidly, avoiding thereby the greater expense that will naturally be connected with slow progress, on suspension of work, by allowing the currents time to deepen the bar ahead of the advancing jetties; while the ever-changing condition of the bar, and of the channels leading through the same, as long

as the currents are not suitably controlled by the jetties, will complicate the problem, and still more increase the cost of the work.

This work is located in two collection districts, the north jetty being in the collection district of Saint Mary's, Ga., and the south jetty in that of Fernandina, Fla. Fernandina is the nearest port of entry.

The following appropriations have been made :

By act of Congress approved June 14, 1880	$30,000
By act of Congress approved March 3, 1881	100,000
Total	130,000

The expenditures to June 30, 1882, including outstanding liabilities, amounted to $114,256.89.

The following papers accompany this report:

Longitudinal section and diagram of widths of the north jetty.
Report of Capt. J. C. Post, Corps of Engineers.

Money statement.

July 1, 1881, amount available		$128,922 98
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$78,988 54	
July 1, 1882, outstanding liabilities	30,191 33	
		109,179 87
July 1, 1882, amount available		19,743 11
Amount appropriated by act passed August 2, 1882		50,000 00
Amount available for fiscal year ending June 30, 1883		69,743 11
Amount (estimated) required for completion of existing project		1,841,023 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		500,000 00

Abstract of proposals for construction of jetties at entrance to Cumberland Sound, Georgia, and Florida, opened November 1, 1881.

No.	Bidders.	For log mattresses per square yard.	For brush per square yard.	For riprap stone per cubic yard.	Remarks.
1	Aron S. Lara and John Kirby	$0 98	$0 20	$4 00	Contract awarded to A. M. Newton at the prices stated.
2	A. M. Newton	97	08	3 85	

Abstract of contract for continuing improvement at entrance to Cumberland Sound, Georgia and Florida.

Contractor.	Date of contract.	Nature of work.	To commence.	To complete.
A. M. Newton	November 26, 1881.	Continuing construction of jetties.	January 1, 1882.	July 21, 1882.

REPORT OF CAPT. JAMES C. POST, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., July 1, 1882.

COLONEL: I have to submit the following report upon the work for the improvement of the entrance to Cumberland Sound, Georgia and Florida, for the year ending June 30, 1882.

During the previous year 277 feet of the foundation course of the north jetty had been constructed under the contract of Lara, Ross & Co., by their agents, Messrs. Blaisdell & Greely. They continued laying mats until November, and constructed an additional length of 930 feet, when they abandoned the work. This extension crossed the deepest part of Cumberland or Swash Channel, and was composed of widths varying from 35 to 52 feet. The maximum depth at low-water found in this channel was 13 feet.

In the following month, December, work was again resumed upon this jetty, under a contract made with A. M. Newton, of New York. It has progressed rapidly, and the bottom course has been extended 6,165 feet. This was laid in water, varying from 0 to 10 feet at low-water, and it was constructed 50 feet wide, with the exception of a single mat 51 feet in width.

A second course 1,366 feet long, and of widths of 20 and 25 feet, was laid where the work crosses the channel. This contract will be completed as soon as one mat and 4,609 cubic yards of stone required to give the 1 foot in thickness upon the mats are in position.

In May, Lara, Ross & Co., having closed their contract at Saint John's River, they commenced work upon the south jetty under their unfinished contract. This jetty was located, by your direction, near the upper or north end of Amelia Island, and given a bearing due east; 1,316 feet of the foundation course has been constructed, of widths varying from 40 to 50 feet, and the contract completed. The greatest depth found where this work was laid, was 5.3 feet at low-water.

The following progress has been made upon the jetties up to the present time:

NORTH JETTY.

		Feet.
Length of foundation course reported last year	277	
Length of foundation course constructed during year ending June 30, 1882	7,095	
		7,372
Length of second course constructed during year ending June 30, 1882		1,366
Total length of both courses constructed up to June 30, 1882		8,738

SOUTH JETTY.

Length of foundation course constructed during year ending June 30, 1882, 1,316 feet.

CONDITION OF THE WORK AND ITS EFFECTS.

In the vicinity of the north jetty on Cumberland Island the beach has increased to such an extent that the low-water line has advanced 350 feet and completely covered the work. The current in the channel, along the front of the beach, has increased in strength, particularly on the flood-tide, and produced a scour from 1 to 3 feet on both sides of the work. This increased depth extends a considerable distance above and below, especially the latter, and at the lower or south end of the island both the high and low water lines have receded about 60 feet. No settlement has been detected where the work crosses the channel. The ends of the logs of the foundation course were found to be well covered with sand. In sinking the second course great care was used to cover the ends of the logs with stone.

Beyond the channel the extreme shoal water causes much of the work to be partly, and some of it wholly, exposed at low-water. The overhanging portions of the brush on all those mats which can be seen have entirely disappeared, and none can be detected in those submerged.

There has been little, if any, accumulation of sand at the ends of the logs or on the work. Generally speaking, there was a slight deepening from scour along this part of the work as it progressed. This has been retained and increased somewhat by the current flowing along its sides and across it when the tide is sufficiently high. The strength of these currents has been so great that where small gaps were left by the contractor failing to lap his mats, or butt them end to end, an increased depth of from 1 to 3 feet has been found. In one case this scour caused about one-half of each of the adjacent mats to settle. All of these places have now been closed, and the work is apparently secure except from the ravages of the teredo. Its protection against this ship worm is regarded of especial importance, as without it the entire wood-work of the foundation course may be destroyed in a single year. This can be best attained by inducing a permanent accumulation of sand about the work. Lying as it does on the top of extensive shoals, where the movement of the sand is comparatively slight except during storms, this is not likely to take place rapidly unless something is done to cause the deposit of all the drifting sand in its immediate vicinity. At present the greater portion of what is thrown upon the work by one sea is washed away by the next, and so on, and the accumulation is exceedingly slow. To increase this effect and hold all the sand that is deposited, it is proposed to form a narrow ridge of riprap stone, 2 to 3 feet high, along the axis of the work. By giving this flat side slopes, such as it would naturally assume in the breakers, it is thought that it will catch all the moving sand and soon cause the work to be entirely covered.

The completion of the full amount of stone required on the mats will undoubtedly expedite the deposit somewhat; but even with this, additional stone, placed as suggested, is considered necessary before the work will be thoroughly protected in this shoal water. If the current at the ends of the logs continues to scour, this can easily be checked by placing mats, as short spurs, at proper intervals along its sides.

The portion of the south jetty now constructed has been too recently laid and is too short to have had much effect. Beyond an increase in the rapidity with which the beach and the shoals near its site have been forming, nothing has been observed. Since the survey of 1879 the high-water line of this portion of Amelia Island has advanced 350 feet.

Neither of the jetties for this improvement has been sufficiently extended, as yet, to warrant the expectation of any effect being produced by them on the bar.

The length required in the north jetty before the bar is reached is about 20,000 feet, or nearly 4 miles, and but 7,400 feet, or a little more than 1¼ miles, have been constructed. The same extension for the south jetty requires a length of 11,000 feet, or about 2 miles, and only about one-fifth of a mile of this has been laid. Both must therefore be prolonged very considerably before any change that will affect the draught of water entering the port can be attributed to them.

From a recent instrumental location of the entrance buoys, it seems that the outer portion of the north channel has moved some 300 feet towards the north since the last examination. This is confirmed by the pilots. The south channel has become so shoal that it has been abandoned and the buoys removed.

Before work is commenced under a new appropriation it is suggested that the foundation course of both jetties be carefully examined to ascertain if some protection is needed to preserve them from the teredo. This should be done immediately, if found necessary. In the continuance of the work it is suggested that both jetties should be extended, the north one principally, as it is thought that it will give greater protection to the present channel.

This improvement is located in two collection districts, the north jetty in that of Saint Mary's, Ga., and the south jetty in that of Fernandina, Fla.

Fernandina is the nearest port of entry.

The following drawings accompany this report:

Sheet 1, showing the site of the two jetties, the progress made, and the recent soundings.

Sheet 2, showing longitudinal section, and diagram of widths of both jetties as constructed.

Very respectfully, your obedient servant,

J. C. Post,
Captain of Engineers.

Lieut. Col. Q. A. Gillmore,
Corps of Engineers, U. S. A.

J 10.

IMPROVEMENT OF SAINT JOHN'S RIVER, FLORIDA.

During the fiscal year ending June 30, 1882, the work of improving the channel over the bar at the mouth of the Saint John's River, Florida, was continued in conformity to the project submitted in my communication to the Chief of Engineers dated June 30, 1879, and printed as a part of Appendix I 7 of the Annual Report of the Chief of Engineers for 1879.

The plan of improvement essentially consists in the construction of two low jetties built of riprap stone, supported by a foundation mattress or platform of logs, with a mattress hearting wherever found practicable, to reduce the cost of the work.

Two plans were discussed, differing from each other in magnitude and probable effects.

One plan contemplated the construction of two long jetties starting from the opposite shores of the entrance and extending seaward across the bar.

By the other plan only one long jetty, that upon the north shoal, would be constructed, and a short spur on the south side.

Some works of improvement in the river proper, between the bar and the city of Jacksonville, constituted a requisite part of the larger project.

The usual available low-water depth over the bar in its unimproved condition was 6 feet, more or less, with a mean rise and fall of tides of about 5 feet.

By carrying out the larger project it is expected that a mid channel depth of 15 feet at mean low-water can be obtained at an estimated cost of $1,306,409.

With a long jetty only on the north side and a spur-jetty on the south side, it is calculated that a practicable high-water depth on the bar can be secured equivalent to, and perhaps exceeding, the greatest draught that can at present be carried from the bar to Jacksonville. This plan could probably be executed with the expenditure of $800,000.

The cost of improving several deficient reaches of the river below Jacksonville, a work which should be done when a low-water depth of 15 feet or more has been established on the bar, was not included in the estimate of $1,306,409 for the larger plan. Such works are considered to be properly the subject of a special project, and to be built by means of separate appropriations.

Since the general plan of improvement of June 30, 1879, has been adopted, two appropriations were made by Congress for this work, aggregating $225,000.

Previously a total sum of $57,476.28 was expended in dredging, for the temporary improvement of the bar-channel since the close of the civil war.

For making the preliminary surveys and preparing the project, the sum of $2,523.74 was expended.

SUMMARY OF OPERATIONS PRIOR TO JUNE 30, 1881.

Work was commenced in December, 1880. The operations consisted in laying the apron-foundation of a portion of the south jetty. Nothing was done on the north jetty.

The shore end of the south jetty, beginning at the high-water line, was laid to a length of 874 feet, on a range bearing north 46° 45′ east. At a point of this line 74 feet from the outer end, and near the low-water line, the main line of the jetty begins, following a range bearing north 74° 54′ east. A first or bottom course of log-mattresses covered with brush and stone was laid upon this range for a length of 1,912 feet.

The aggregate length of apron foundation laid was, therefore, 2,786 linear feet.

The width of mattresses ranged from 20 to 87 feet; their thickness from 19 to 21 inches, and the thickness of mattress and stone combined from 34 to 36 inches. The total quantity of riprap stone deposited on the mats was 6,029 cubic yards. This work crossed the old south channel of entrance, where the greatest depth encountered was 22.8 feet at low-water.

All the work was done by Messrs. Lara, Ross & Company, under the contract entered into with them on September 4, 1880, as stated in my last annual report.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1882.

The apron foundation of the south jetty was farther extended seaward, and from one to four additional courses of log mattresses and riprap stone were placed over portions of the bottom course to raise the work to a higher level. Spurs were constructed at some points of the main line to protect and strengthen the jetty.

The north jetty was commenced by laying a portion of its apron foundation.

The operations were carried on under two different contracts. That made with Messrs. Lara, Ross & Co. on September 4, 1880, was terminated during the last fiscal year. Work under the other contract entered into with Mr. J. H. Durkee, of Jacksonville, Fla., on June 10, 1881, already referred to in my last annual report, was not yet completed on June 30, 1882, but will be so, probably, within a few weeks from that date.

Under the contract made with Mr. Durkee, the mattresses he had to furnish and put down were simply rafts of round logs of not less than 12 inches in average diameter, held together by transverse binders spiked or bolted to the logs. These binders were to be logs or poles of not less than 4 inches diameter at the small end, placed not more than 8 feet apart; those on the outside to be close to the end of the logs.

It was subsequently thought desirable to increase the thickness or height of the mattresses by filling in the spaces between the binders on top of the logs with poles or saw-mill slabs. With the approval of the Chief of Engineers a supplementary contract was entered into with Mr. Durkee on April 6, 1882, according to which he was to supply and put in place such poles or slabs when directed, at the price of $2.55 per cubic yard.

South jetty.—The apron foundation of the south jetty was extended 2,027 linear feet, the mats varying from 55 to 78 feet in width. The first 1,626 linear feet follows the original direction of the main line north 74° 54′ east. In laying the next 328 feet the line was deflected one degree to the east, which was followed by another deflection of two degrees more eastward. Only 73 feet were laid on this last range, which bears north 77° 54′ east.

A second course of mats covers the greater part of the length of the apron of the main line, the total length of the course being 3,002 linear feet. The width of the mats varies from 42 to 77 feet.

The second course is further overlaid with from one to three additional courses of mats, depending on the depth of water. The aggregate lengths of the third, fourth, and fifth courses are, respectively, 1,776 feet, 1,380 feet, and 331 feet. In every case the mattresses of these courses were about 8 feet less in width than those immediately below them.

About 1,000 feet in length of the jetty, next to the angle of junction with the shore line, now reaches up to the level of low-water. The next adjoining 500 linear feet are about 1 foot lower, and the balance is from 2 to 13½ feet below the level of low-water.

The latter depth was temporarily reserved for a length of 300 feet to permit vessels to cross the jetty, because the work has not yet advanced far enough to force the main channel across the bar into the position designed for it north of the south jetty.

Considerable scour having been developed on both sides of the jetty during the past fiscal year, which ultimately might threaten the stability of the work, eight spur-jetties were constructed, four on each side, opposite to each other. They are located at distances of from 500 to 1,800 feet from the angle of junction with the shore end, and are at present formed of two courses of mattresses with riprap stone on top. The foundation courses of the spurs are from 81 to 98 feet in length; the width is 75 feet on the north side of the jetty, and 100 feet on the south side. The second courses are both shorter and narrower than the first courses. These spurs will have to be raised higher.

Since July 1, 1881, there were deposited 18,504 cubic yards of riprap stone on the south jetty, a portion of which was used for leveling off the top of the work. This was generally done at those places where the superstructure had reached a height of less than 4 feet below the low-water line.

North jetty.—The work of laying the apron foundation of the north jetty was commenced in January, 1882.

On June 30, 1882, the bottom course had reached a length of 1,115 feet, beginning at the low-water line of Fort George Island. The mattresses, logs, and brush, or logs and poles together, are from 19 to 22½ inches thick, and vary from 42 to 60 feet in width. They are held in place by 2,162 cubic yards of riprap stone distributed over them. The axis of the jetty is a straight line bearing south 73° east. The greatest depth along the work is about 7 feet at low-water. The seaward end of the apron is in the vicinity of a large shoal east of it and known as Ward's Bank. This shoal as at present located practically forms a continuation of the jetty at and above the level of low-water, for a distance of about 2,000 feet.

CONDITION OF THE WORK.

As far as can be observed, both jetties are in a good condition generally.

The first mat of the north jetty, placed near the line of low-water, has now nearly 2 feet of sand over it, owing to the growth of the lower part of the beach of Fort George Island in the vicinity of the jetty. The last mat laid, near Ward's Bank, is similarly covered up, that shoal apparently growing toward the jetty.

On the main line of the south jetty no settlement has been noticed except in a slight degree in the heavier parts, which is ascribed to the gradual compacting of the several courses. Sand was found to have freely accumulated on the second course of mats when the third tier was sunk thereon.

The shore end of the south jetty settled from 1 to 4 feet on a portion of its length, which was undoubtedly caused by the little rivulet known as South Run, that crossed the line obliquely and produced underscour. It has now changed its course, and the depression in the shore end has been gradually filling up with drift sand.

EFFECTS OF THE WORK AND CHANGES GENERALLY.

The beach at Fort George Island, near the north jetty, has made out seaward, but the high-water line is still some 300 feet inside of its general position three years ago. The beach has become flatter than it was formerly. No unfavorable changes have been observed here lately, and the beach is considered to be at present in a condition of stability.

Ward's Bank rises from 1 to 5 feet above the low-water level. The main body of this large shoal lies across the proposed path of the north jetty, while the spit of its easterly elongation overlaps the axis of the south jetty when produced, about 700 feet east from its present seaward end. During the first part of the fiscal year the shoal seemed rather to grow towards the south jetty, but since the latter has been raised, on a large part of its length has been again receding northward. In connection with this washing off, there are recent indications that a temporary channel may again break out to the north, as it has done occasionally before.

No material changes have taken place in the shore lines near the south jetty since the last year.

Pelican Bank is now still nearer to the shore than it was a year ago, and the area exposed at low-water is much reduced. The fall gales of 1881 washed off its entire top and carried it into the deep basin south of the jetty. About a year ago the surface of the shoal was not less than 2 feet above high-water. In December, 1881, it was entirely under water at half-tide.

In the deep basin just mentioned sand is fast accumulating, except in the vicinity of the jetty.

As a consequence of the raising of the inner portion of the main line of the south jetty, the point where the present sailing line crosses the work has been pushed farther out. It is now about 700 yards from the angle of junction of the main line with the shore end; in August, 1881, the distance was about 570 yards, and at the beginning of operations perhaps 260 yards. The channel crosses the axis of the jetty at an angle of 22°. The least depth of water on the bar on the channel line is 9 feet at low-water.

Considerable scour has lately occurred on both sides of the raised portions of the south jetty, causing an increase of depth of from 9 to 16 feet at a distance of about 25 feet from the edges of the apron foundation. On the south side of the jetty this deepening is ascribed chiefly to the water falling over the top of the work, since the currents along the jetty are not considerable; but on the north side strong currents run more or less parallel to the axis of the work, and the greatest scour is produced near the end of the raised work. To force these currents away from the north side and fill up the scoured holes on both sides, spurs have been built; but more will probably be needed. A mattress apron may also be necessary at some points.

The channel over the bar has certainly improved of late, but it is not yet in the proper position, and is liable to changes, and it will continue to be in a state of transition until the south jetty is further extended and has been brought to a greater height. It is reported that the sand in the whole outer harbor is active, and that shoals are often formed unexpectedly, only to disappear again in a short time. These phenomena of transformation are due, at least in part, to the south jetty, which hastens, and doubtless in many cases initiates these changes, but the work has not yet sufficiently advanced either in length or height to control these movements. Generally speaking, however, the prospects of ultimate success are sufficiently encouraging.

OPERATIONS CONTEMPLATED DURING THE FISCAL YEAR ENDING JUNE 30, 1883.

On July 1, 1882, the sum of $6,771.18 was available, being the unexpended balance of last year's appropriation. It is to be applied to strengthening the spurs of the south jetty lately commenced.

If an appropriation for this improvement is made by Congress at its present session, it is intended to increase the length and height of the existing spurs of the south jetty and build additional works of similar description, if necessary. The jetty itself will be built up to the level of low-water where it has not yet attained that height, leaving, however, a gap of ample width and depth for the passage of vessels over it until a channel in the desired locality is opened. In view of the scour that will be induced by raising the work, additional mattresses will be sunk to increase the width of the apron foundation, especially at or near the gap where strong currents are anticipated when the work shall have been raised on either side. It is proposed to attend to these operations first, as it is impracticable to extend the apron of the south jetty immediately. The water ahead of the present seaward terminus of the jetty is very rough and very shallow for the next half mile; the low-water depths for that length in the prolongation of the axis of the work range from less than 1 foot to 5 feet at most. When the jetty shall have been raised as far as the present apron foundation extends, it is expected that strong currents will pass around the head of the work, creating better depths, which will permit the extension of the jetty seaward.

Whether any work shall be done on the north jetty during the present fiscal year will depend on circumstances. Nothing need be done, it appears, if Ward's Bank preserves its present condition. If sufficient depths are being developed in the prolongation of the axis of the work, the apron foundation of the north jetty may be further extended, if means shall be on hand after providing for the more important work on the south jetty.

Jacksonville is the seaport of the Saint John's River, and is situated about 24 miles from its mouth. The anchorage in front of the city is deep and capacious. During the year ending June 30, 1882, there arrived at this port 487 vessels with an aggregate tonnage of 158,961 tons, and 501 vessels cleared of a total tonnage of 159,550 tons. A large business was done in lumber, of which 83,261,759 feet was shipped during the year.

By far the larger number of vessels and tonnage are engaged in the coastwise trade. The foreign commerce is small, and will continue to be so until the channel of entrance at the mouth of the river shall have been permanently located and deepened.

The river from the bar to the wharves at Jacksonville is generally in a good navigable condition except at the bend at Dame's Point. A report on the condition of the ship-channel in that vicinity was submitted by me to the Chief of Engineers under date of March 25, 1872, printed as a part of Appendix P 5 of the Annual Report of the Chief of Engineers for 1872. In my annual report for the year 1879 the cost of such works as would be needed for the permanent improvement of the river at Dame's Point was estimated at $120,000, an estimate which is subject to revision when the government shall decide to make this improvement, and when a new survey shall have been made. Although the acts of Congress of 1880 and 1881, by which appropriations were made, simply provide for the improvement of the Saint John's River, without any qualification, it was understood that the funds thus provided were to be expended in improving the mouth of the river, and that the amelioration of the river proper requires special appropriations. This remark also applies more or less to the case of the wreck of the steamer Maple Leaf. This boat was sunk by the explosion of a torpedo during the civil war, near Mandarin Point, 15 miles above Jacksonville. A communication was received from the Chief of Engineers dated March 16, 1882, requiring a report to be made on the alleged obstructions to navigation formed by this wreck, as complained of by parties navigating the river.

An examination having been made, it was recommended that the wreck be removed in accordance with section 4 of the river and harbor act of June 14, 1880, and notice was given by advertising to parties interested in vessel or cargo to remove the wreck as soon as practicable, as otherwise it will be considered as derelict, to be removed by government.

I have nothing new to add to the few remarks made by me in my annual report for the year ending June 30, 1881, in regard to the amount of commerce and navigation that will be benefited by completing the work of improvement now in progress at the mouth of the Saint John's River. With a deep channel secured across the bar, the maritime commerce of Jacksonville will soon assume larger dimensions, and a strong impulse will be given to the development of the natural resources of a large portion of the State of Florida.

This improvement is located in the collection district of Saint John's; Jacksonville is the nearest port of entry. Import duties for the year ending June 30, 1882, $4,455.09.

The following appropriations have been made for this work since the present project of improvement was adopted:

By act approved June 14, 1880	$125,000
By act approved March 3, 1881	100,000
Total	225,000

The estimated cost of the improvement is $1,306,409.

The expenditures up to June 30, 1882, amounted to $218,228.82, including outstanding liabilities.

The following papers accompany this report:

Sheet 1, chart of entrance, showing progress of work and results of recent surveys.
Sheet 2, showing longitudinal sections and diagrams of widths of the south jetty.
Report of Capt. J. C. Post, Corps of Engineers.

Money statement.

July 1, 1881, amount available		182,703 08
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$152,677 67	
July 1, 1882, outstanding liabilities	23,254 23	
		175,931 90
July 1, 1882, amount available		6,771 18
Amount appropriated by act passed August 2, 1882		150,000 00
Amount available for fiscal year ending June 30, 1883		156,771 18
Amount (estimated) required for completion of existing project		1,081,409 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		600,000 00

REPORT OF CAPT. JAMES C. POST, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., July 1, 1882.

COLONEL: I have to submit the following report upon the work for the improvement of Saint John's River, Florida, for the year ending June 30, 1882:

During the last year work has been done on both jetties under two contracts, one with Messrs. Lara, Ross & Co., and the other with Mr. J. H. Durkee. The former constructed on the south jetty 2,027 feet of the first or foundation course varying from 55 to 78 feet wide, 3,002 feet of the second course from 42 to 77 feet wide, and on the north jetty 635 feet of the first course 42 to 61 feet wide. Total length of the different courses of both jetties, 5,664 feet. The latter constructed on the south jetty 1,776 feet of a third course 34 to 69 feet wide, 1,380 feet of a fourth course 30 to 57 feet wide, and 331 feet of a fifth course 32 to 50 feet wide, and on the north jetty 480 feet of the first course 49 to 60 feet wide. Total length of the different courses of both jetties laid by J. H. Durkee, 3,967 feet.

In addition to the above, under the second contract, 4,072 cubic yards of stone in excess of the 1 foot in thickness required on each course were placed upon the top of the south jetty, where the water was too shoal to lay another course of mats. In this manner the work was raised level with low-water for a distance of about 1,000 feet from the beginning of the second range or main direction of the work, and to about 1 foot below low-water for an additional distance of 500 feet. The remainder of the work, to the end of the fourth course, a length of 350 feet, has a general level of from 2 to 3 feet below low-water. Very little of the extra stone has been placed upon the latter portion.

Eight spurs, each about 90 feet long, and composed of two courses of mats, the second being 55 feet in length on the north side and 60 feet long on the south side, were also constructed. These have been completed, with the exception of 1,073 cubic yards of stone. When this is in place, which will probably be done before the first of next month, the appropriation available for this contract will be exhausted. The contract with Messrs. Lara, Ross & Co. has been completed.

The following progress has been made upon the jetty up to the present time:

SOUTH JETTY.

		Feet.
Length of first course, reported June 30, 1881	2,786	
Length of first course constructed this year	2,027	
		4,813
Length of second course constructed this year		3,003
Length of third course constructed this year		1,776
Length of fourth course constructed this year		1,380
Length of fifth course constructed this year		331
Length of spurs, first course, constructed this year	717	
Length of spurs, second course, constructed this year	427	
		1,144
Total length of the several courses and spurs June 30, 1882		12,447

NORTH JETTY.

Length of first course constructed June 30, 1882, 1,115 feet.

The widths of the first or foundation courses were determined by the depth of water in which they were placed. The second course was made 10 feet narrower than the first, and each of the succeeding courses was 8 feet less in width than the one which precedes it. These courses vary in thickness from 2½ to 4 feet, depending upon the terms of the contract under which they were constructed. Of the extension of the south jetty made during the year, 1,626 feet were laid on the second or main range, 328 feet on a line deflecting 1 degree, and 73 feet on a line deflecting 2 degrees from this range, in accordance with your instructions.

CONDITION OF THE WORK AND ITS EFFECTS.

As far as can be ascertained without the aid of a diver, both jetties are in perfectly good condition. Examinations made from time to time have developed considerable scour along both sides of the raised portion of the south jetty. In some places a deepening of from 9 to 16 feet has been found about 25 feet from the base of the work, but as yet no settlement has been detected in any portion of it, except from a consolidation of the different layers comprising it. It is impossible to have the riprap stone distributed so evenly upon the various courses that its upper surface, upon which a mat is to be laid, will be free from considerable irregularities. This gives each of the courses a greater thickness when first laid than they have later when they are heavily weighted by those above them. The irregular settlement of about 1 foot, which was observed, was accounted for in this way.

The scour on the south side is principally due to the fall of the layer of water passing over the work, as there is but little current along this side, except at the higher stages of the tides, when the water can pass freely over its inner or shore end. Raising the work to the level of low-water has diminished this layer and retarded the scour.

On the north side, where the ship channel is situated, and is limited by the work, the current is very strong, and the scour, especially near the extremity of the raised portion, has been very great. To remove this action from the base of the work and reform the scoured bottom on both sides, several perpendicular spurs have been constructed at those places where the greatest deepening has taken place. These have been made as large as the balance of the appropriation would permit, but it is not expected that they are either of sufficient length or height to answer fully their purpose. All the mats forming these spurs are in position, but until the entire complement of stone is in place their full effects cannot be known. While laying the mats the contractors experienced great difficulty in getting them properly set, because of the eddies formed by the currents impinging against the work. The bridle lines holding them were necessarily long—some 20 to 35 feet—and the effect of the eddies was to twist the mats out of position as they were settling upon the bottom. The entire work rests upon a sandy bottom, except at the ridge where the second set of spurs, reckoning from the west, is located. At this place there seems to be a bed of stiff blue clay, but as even in this a depth of 9 feet was scoured out, and as this part of the foundation course was quite narrow, it was thought best to protect it.

The north jetty was commenced at the line of low-water on the beach of Fort George Island and given a direction south 73° east. It was extended in a straight line towards a large shoal known as Ward's Bank, which is from 1 to 5 feet high at low-water. The beach in rear of the first mat has increased and covered it with sand, and Ward's Bank has grown towards the work and covered the last mat. This closes the entire shallow channel between the shoal and the beach at low-water, except at the narrow depressions in the work. The high-water line at this place has receded 300 feet between the survey of 1878 and the one made in December last to locate the north jetty. No change has been noticed since then, except in the growth of the beach below this line.

There has been but little or no change in the beach south of the south jetty as far east as the Atlantic House, during the past six months. Prior to this time, and since the survey of 1878, considerable erosion had been observed in the vicinity of the latter. From this point to the Burnside House, on the front beach, a very material increase has taken place.

Between the jetty and the beach, which includes the Old South Channel, there has been a marked shoaling, except within a distance of about 200 feet of the work, and Pelican Bank has moved very much nearer the south shore. Comparative soundings taken recently, more than a month apart, do not indicate any additional change. At the shore end of this jetty, where the work is but 20 feet wide, the change of direction of an outlet from the marshes known as South River caused a portion 200 feet long to settle from 1 to 4 feet. This was about 40 feet from the inner end of the shore connection, near high-water line. The stream has again changed its direction and left the work, and the depression caused by the settlement has filled with drift sand. The high-water line is about the same as originally.

The inner portion of the channel remains in about the same position as it was a few years ago, with the exception of its place of crossing the line of the south jetty. This has moved seaward about 400 feet, and is undoubtedly the result of extending the raised portion of the jetty. It was expected that by encroaching upon the channel on its south side it would be pressed gradually northward and eastward until it connected with the sea north of the jetty. The raised part of the work was extended as far as the appropriation would allow, before it became necessary to construct the spurs, but the shoals beyond, protected by the extension of the two courses of mats, have, up to the present time, prevented the spread of the current a greater distance. The seaward end of the channel in January last, when I assumed charge of the work, under your direction, extended well toward the south. Since then it has gradually advanced northward until now its general direction makes an angle of about 22° with the second or main range of the work, and it contains a greater depth by 2 feet than is given in either channel by the survey of 1878. The least depth in this channel over the bar is 9 feet at low-water, or 13.5 feet at high-water. The depth of water where the channel crosses the work is 13.5 feet at low-water.

North of the channel, Ward's Bank, which had increased materially towards the south since the last report, has again scoured away as the south jetty was raised. This scouring is apparently continuing, and at present there seem to be indications that the channel may again break out north of the jetty in the direction of the wreck of the steamer Lizzie Baker. It has already occupied this position in former years. Sudden changes have often been noted in the channel across this bar, and frequently the effect of a single gale is to give it an entirely new direction. It is not at all improbable, therefore, if the present conditions continue, that, if a new channel is not formed before the usual autumn gale, that one will break out in the direction indicated at that time.

When work is resumed under another appropriation, the protection of the south jetty being of first importance, an examination should be made to ascertain if additional work for this purpose is needed. If the scour still encroaches upon its foundations on the north side, the spurs should be increased in length and height, and possibly others should be built. If it continues on the south side and is likely to undermine the work, it will probably be necessary to form an apron between the spurs to receive the falling water. The length of the spurs on this side is likely to prove sufficient, unless the current along the work is increased; their height might be added to with with good effect.

As soon as the work in its present advanced state is made secure, if the direction of the channel remains unchanged, the remaining portion for which the foundation has been laid should be raised to low-water after leaving a gap of 300 feet wide for the accommodation of commerce. This gap with the rapid current, which will, without doubt, flow through it, will always be a source of danger to the work, and it should be closed as soon as circumstances will permit. In forming it by sinking the additional courses of mats, precautions should be taken to strengthen those parts of the jetty adjacent to it. It is thought preferable to raise this portion as proposed before extending the foundation course in order to create scour. By this means it is expected a greater depth of water will be obtained in which this course can be laid and thus give greater protection to it from the action of the heavy seas.

The present condition of the shoals on the north side of the channel renders the further extension of the north jetty unnecessary. Should these change so as to permit the laying of the foundation of its extension in a fair depth of water, from 4 to 8 feet at low-water, it should be continued, even if, by reason of the intervening shoals, it is necessary to leave large gaps. These latter could be filled as soon as the water became of sufficient depth.

The principal article of export from this river is lumber, of which over 83,000,000 feet have been shipped during the year ending June 30, 1882.

This improvement is located in the collection district of Saint John's. Jacksonville is the nearest port of entry. Import duties collected for the year ending June 30, 1882, $4,455.09.

The following drawings accompany this report:

Sheet 1. Showing site of the two jetties, the progress made, and the recent soundings.

Sheet 2. Showing longitudinal section and diagram of widths of both jetties as constructed.

Very respectfully, your obedient servant,

JAS. C. POST,
Captain of Engineers.

Lieut. Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

J 11.

IMPROVEMENT OF VOLUSIA BAR, FLORIDA.

During the fiscal year ending June 30, 1882, the work of improving Volusia Bar, Florida, was carried on in conformity to the plan submitted with my report of July 16, 1879.

The existing plan of permanently improving Volusia Bar comprises the construction of two jetties, with a view of establishing a channel depth of 6 feet. Heretofore the low-river depth on the bar has occasionally not exceeded 3½ to 4½ feet. For this purpose the jetties were to be carried out beyond the bar into about 6 feet of water, with their outer ends 200 to 250 feet apart, and their crests at the level of low-water. These two jetties were estimated to cost $15,000.

Volusia Bar is located at the south end of Lake George, about 162 miles from the mouth of the Saint John's River, at a point where the waters of the river discharge into the lake.

The first appropriation ever provided for improving this locality, amounting to $5,000, was made by act of Congress approved June 14, 1880.

A second appropriation of $5,500 was made by act approved March 3, 1881.

WORK DONE PRIOR TO JUNE 30, 1881.

The work of improving Volusia Bar was commenced with the first appropriation of $5,000.

The west jetty was built to a length of 1,950 linear feet, extending from the shore to about 3½ feet depth of water on the bar. For a length of 988 feet from shore the width of the mats was made 6 feet, widening to 9 feet in a length of 32 feet, while the outer portion, 930 feet long, was made 12 feet wide.

The mattresses were made of poles and brush, and they were covered with broken stone averaging 50 pounds per square foot of mattresses. The height of the jetty along the crest varies from 2 to 2½ feet.

Some piles were driven as fenders to keep boats from running against the work.

OPERATIONS DURING THE LAST FISCAL YEAR.

On July 1, 1881, the sum of $5,500 was available for continuing the work of improving Volusia Bar.

Proposals for expending that sum, by extending the west jetty across the bar to the 6-foot curve, and beginning the east jetty, had been ininvited on May 28, 1881.

The specifications provided for the jetty-work to be composed of a compact pole and brush-mattress 12 inches thick, exclusive of the pole binders on top and bottom, covered with broken stone to a depth of from 6 to 18 inches, as might be directed.

Only one bid was received, which was rejected as being too high.

As authorized by department letter dated June 29, 1881, copies of the specifications just referred to were circulated among contractors familiar with the kind of work therein described.

Two proposals were received. The lowest bid was made by Mr. L. A. Cunningham, who offered to furnish and put in place mattresses at the price of $1 per square yard, and broken stone at the price of $6 per cubic yard. With the approval of the Chief of Engineers, the contract was awarded to Mr. Cunningham, under date of December 7, 1881.

Operations commenced in January, 1882. Some weeks were spent in collecting and preparing the necessary material; towards the latter part of February the first mats were laid for the east jetty.

From an examination made about the end of February, 1882, by my assistant, Capt. J. C. Post, Corps of Engineers, it appeared that the bar had made out into the lake for a length of about 150 feet since the construction of the west jetty was commenced. It was thought expedient to adopt means for opening a channel of about 75 feet width and from 6 to 7 feet depth across the bar, by driving two rows of piles, arranged in clusters, between the two jetties. These piles would prevent the steamers from grounding on the jetties, and require them to follow the same course in passing over the bar. The action of the steamers was expected also to keep open a channel of adequate depth when once made, by confining them within the narrow limits of the piling.

This additional work was approved by the department, and since it was not provided for in the contract of December 7, 1881, a supplementary agreement was entered into with the contractor, Mr. Cunningham, on March 31, 1882, under which he was to furnish and drive piles across the bar inside the lines of jetties, as might be directed by the engineer in charge, at the price of $12 per pile for 50 or more up to 75 piles, or $11 for 75 or more up to 100 piles, and $10 per pile for 100 or more. The piles were to be 25 feet long, not less than 12 inches in diameter at the large end, and were to be driven 10 feet, or as far as would be considered reasonable by the engineer in charge.

Operations were closed in May, 1882, the appropriation having become exhausted.

The work done comprised the construction of 1,836 linear feet of the bottom course of mattresses on the line of the east jetty of 6 feet width beginning from shore. The west jetty was extended across the bar by a bottom course of mats 12 feet wide, and aggregating 256 feet in length. A second course of mats of 6 feet width, and aggregating 159 linear feet, was placed on the outer portion of the west jetty. About 1,660 square yards of mattress and over 370 cubic yards of broken stone were placed in executing the work. There were also one hundred piles driven in clusters of three and four to confine the passage of boats over the bar to a channel 75 feet in width.

The bottom course of the west jetty has now reached a length of 2,206 feet.

The bar has narrowed, and has increased about 1 foot in depth since the survey of 1879 was made.

OPERATIONS CONTEMPLATED DURING THE PRESENT FISCAL YEAR.

With such appropriation as shall become available, it is proposed to continue work on the east jetty and make a resurvey of the locality, in order to see whether material changes have occurred since the survey was made, a report of which, dated July 16, 1879, was printed as Appendix I 9 of the Annual Report of the Chief Engineers of 1879, and to determine what additional work, if any, will be required to secure a permanent channel of sufficient depth over the bar.

It is probable that the original estimate will be somewhat exceeded in completing the improvement, since the jetties will be longer than first calculated, and their outer portions will be higher and consume more material, being located in water from 5 to 7 feet depth. The piles lately driven formed no part of the original project. Some dredging may also have to be done.

As to the amount of commerce and navigation that would be benefited by the completion of the improvement of Volusia Bar, I beg leave to refer to the few remarks made on that subject in my annual report to the Chief of Engineers for 1881.

This work is located in the collection district of Saint John's. Jacksonville is the nearest port of entry. Amount of duties collected in 1881, $4,455.09.

The following papers are transmitted herewith:
Report of Capt. J. C. Post, Corps of Engineers.
Chart of Volusia Bar, showing sites of jetties.

Money statement.

July 1, 1881, amount available		$5,500 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$5,389 00	
July 1, 1882, outstanding liabilities	45 00	
		5,434 00
July 1, 1882, amount available		66 00
Amount appropriated by act passed August 2, 1882		5,000 00
Amount available for fiscal year ending June 30, 1883		5,066 00
Amount (estimated) required for completion of existing project		1,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		1,000 00

Abstract of proposals for constructing jetties at Volusia Bar, Florida, opened September 28, 1881.

No.	Bidders.	For brush mattresses per square yard.	For riprap stone per cubic yard.
1	L. A. Cunningham, Batavia, N. Y.*	$1 00	$6 00
2	J. C. Greeley, Jacksonville, Fla	1 50	6 75

*Contract awarded at prices stated. Work completed in May, 1882.

REPORT OF CAPT. JAMES C. POST, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Jacksonville, July 1, 1882.

COLONEL: I have to submit the following report of the progress of the work for the improvement of Volusia Bar, Florida, for the fiscal year ending June 30, 1882.

By act of Congress approved March 3, 1881, the sum of $5,500 was appropriated for this work, and operations were commenced upon it under your direction in January last. Since then the east jetty has been constructed 6 feet wide for a length of 1,836.2 feet, the water being generally 2 feet or less in depth at low-water for the entire distance. It was formed of log mats about 30 feet long and 28 inches thick laid end to end. These consisted of a bottom grillage of poles 4 inches in diameter placed 5 feet apart in two courses perpendicular to each other. Two layers of brush, transverse to each other, and aggregating 1 foot in thickness, were then placed upon this, and on the top of the brush another grillage similar to the one underneath was laid, and the two firmly fastened together at the points of intersection of each. About 3 cubic feet of stone were placed on each linear foot of the work, or about 50 pounds of stone to the square foot. The accompanying chart gives the position and a section of the work as constructed. Its outer end lies in water 2.2 feet in depth.

The west jetty, which had been made 1,950 feet long during the previous year, was also extended 256 feet, to a depth of 5.8 feet at low-water. This extension was made 12 feet wide, and the mats were constructed similarly to those of the east jetty, except the outer portion, 159 feet long, where, on account of the increased depth, a double mat was used. A cross-section of this latter is also shown in drawings. About 14 cubic feet of stone were placed on each linear foot of this extension. The work was closed June 1, the appropriation being exhausted.

The constant changes in the bar, which increases during high-water or freshets and scours again during low-water, as well as the shifting character of the channel, caused in part by the shoals formed by the grounding of the passing steamers, induced an attempt, with your approval, to confine the crossing of the latter to a narrow channel. It was thought that, if the action of all the steamers were restricted as nearly as possible to one line, better water and a more constant channel could be maintained than by allowing each vessel to find its own way, run aground, and form some new shoal. Accordingly two lines of piling, 75 feet apart and inclosing the best water, were driven, extending from 6 feet of water outside the bar to the same depth within. They were placed in clusters of three and four, and are located upon the chart, together with the soundings taken just before the close of the work. These latter show a channel of more than 5 feet in depth at low water, or about 1 foot greater than the depth given by the chart prepared by Mr. Daubeney from his survey of 1879. By a comparison of these two charts it will also be seen that the 6-foot curve on the north side of the bar has advanced into Lake George 250 feet, and the same curve on the inside or south of the bar has advanced 375 feet. The bar is, therefore, about 125 feet narrower than it was in 1879. The materials composing it, ascertained while the piles were being driven, are sand for a depth of from 1 to 2 feet, then soft mud or clay 3 to 5 feet, after which very hard bottom was encountered, supposed to be sand.

Lake George, into which the Saint John's River enters at this place, is 12 miles long and 7 miles wide, with a greatest depth of 11 feet given by the Coast Survey charts of 1878. The water deepens so gradually that this depth is not found within 3 miles of the 6-foot curve of the bar, though 9 feet, or a depth of 3 feet greater, is found in a comparatively short distance. This shoal water materially adds to the difficulties of gaining an increased depth in the channel through the use of jetties, as the bar is likely to advance with them as they are prolonged. With the present arrangement, if the steamers can retain, with the aid of the jetties, the present depth in the narrow channel between the piles, it would seem as if the best results possible are obtained, unless dredging is attempted. This latter will be attended by doubtful results, as it will depend upon the ability of the steamers to keep the channel open after it is once dredged. A slight additional and probably beneficial effect might be produced by the extension of the east jetty to the line of piling, and the current across the bar might also be increased somewhat by raising a low place to the level of low-water in each of the jetties as at present constructed. It might also be well to construct a short deflecting spur from the west jetty to prevent the current from leaving the present channel under the influence of the east jetty. Beyond this it appears as, if an attempt to lengthen either of the works was made, it would only result in the advance of the bar without better water, except possibly for a very limited period.

The country likely to be benefited by this improvement comprises at least eight counties in the State, whose united area is 26,300 square miles. According to the latest statistics, those of 1879, the population of this area was about 40,000, and the valuation of the land under cultivation with its improvements $7,500,000. The production from this area for the same year amounted to $800,000. During the past year 8 steamers, making regular trips on the river and crossing this bar, have carried freight valued at $3,800,000, and collected about $54,000 in passenger fares. Still another steamer was run between Palatka and Sanford during the winter months, connecting with the regular day line from Jacksonville. No account of the business done by this boat, which consisted chiefly of carrying passengers, could be obtained. All of the steamers connect with two lines of railroads into the interior. One extends from Astor, 7 miles above Lake George, to Fort Macon, on Lake Eustis, a distance of 28 miles. The other is now running from Sanford to Kissimmee City, at the head of Lake Tohopokeliga, and is 40 miles in length. From Kissimmee City steamers run to Lakes Istokpoga and Okeechobee, a distance of about 140 miles. There are several other projects for the construction of roads to connect with the upper river steamers, which, if built, will largely increase the freights and passengers passing over this bar. On the other hand, the river business may be somewhat reduced by the construction of other roads also contemplated, which are to connect with the through lines running north.

This work is located in the collection district of Saint John's. Jacksonville is the nearest port of entry.

Amount of import duties collected for the year ending June 30, 1882, is $4,455.09.

Very respectfully, your obedient servant,

JAS. C. POST,
Captain of Engineers.

Lieut. Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

J 12.

IMPROVEMENT OF SAINT AUGUSTINE'S CREEK (THUNDERBOLT RIVER), GEORGIA.

By river and harbor act approved March 3, 1879, the sum of $5,000 was appropriated for improving Saint Augustine's Creek, Georgia, constituting a part of the inside passage between the Savannah River and Jacksonville, Fla.

This is the first appropriation ever made by Congress for this river.

The improvement consisted in the partial removal of the wreck of a large timber dry-dock sunk in the middle of the stream during the late civil war. As stated in my last annual report, the wreck was removed to a minimum depth of 10 feet below mean low-water.

There appears to be no necessity at present for any further improvement of the river at this point, and no further appropriation is asked.

This work is located in the collection district of Savannah. Savannah is the nearest port of entry.

Amount of import duties, tonnage dues, &c., collected in 1881, $393,265.84.

Money statement.

July 1, 1881, amount available	$3,417 66
July 1, 1882, amount available	3,417 66

J 13.

IMPROVEMENT OF INSIDE PASSAGE BETWEEN FERNANDINA AND SAINT JOHN'S RIVER, FLORIDA.

By act approved June 14, 1880, the sum of $7,000 was appropriated for continuing the improvement of this passage.

Appropriations for its improvement were made at various times from 1828 to 1838, aggregating $78,000, chiefly expended in dredging out Kingsley's Cut in Amelia River, 3 or 4 miles south of Fernandina, and Gunnison's Cut, in Saw Pit Creek, 4½ miles south of Nassau Sound.

No further appropriations were made until the year 1874.

By act approved June 23, 1874, the sum of $10,000 was appropriated, of which $2,627.60 was employed in making a thorough survey of that part of the route south of Nassau Inlet, about 14 miles in length, except 3½ miles on the northern end of it. The balance of the appropriation was expended during the fiscal year ending June 30, 1876, in dredging at various shoals between Nassau Sound and Saint John's River. It resulted in a cut being made 4 feet deep and 40 feet wide at mean low-water, giving a flood-tide channel of 9 feet depth over the worst shoals.

Two other appropriations were subsequently made of $7,000 by acts approved March 3, 1879, and June 14, 1880.

Since the survey above referred to was made the shoalest portions of the inside passage were temporarily improved by dredging, mainly at the confluence of Sisters Creek and Saint John's River, at Cow Bank, Ocmulgee Point, Deep Water Point, and Gunnison's Cut.

The last-mentioned appropriation of $7,000 was not exhausted when work was suspended on December 1, 1880. Operations have not been resumed since that time, for the reasons that there seemed to be not only no urgent need for their continuance, but no prospect of securing any permanent benefit from the expenditure of small appropriations.

The direct connection of Fernandina and Jacksonville by rail, recently completed, undoubtedly lessens the value of this inland water-route. After the bar at the mouth of Saint John's River, and that river itself as far as Jacksonville, have been improved, passengers and freight between Jacksonville, Fernandina, and Savannah will have a choice between transit by rail, on a moderately quick schedule, and transit by sea and river by coasting steamers.

Still the inside passage between Savannah and Jacksonville, which actually continues far into the interior of Florida, by means of the Saint John's River, may be considered as a valuable water-route for many purposes.

Its importance in the case of the United States becoming involved in war with a maritime power has been pointed out in former reports.

Its improvement, when undertaken, should be on a liberal scale.

The following appropriations have been made for this work since 1874:

By act of Congress approved June 23, 1874	$10,000
By act of Congress approved March 3, 1879	7,000
By act of Congress approved June 14, 1880	7,000
Total	24,000

The total expenditures since 1874, including the cost of the survey, were $19,565.55.

This inland route is partly in the collection district of Fernandina and partly in that of Saint John's, of which Fernandina and Jacksonville are the respective ports of entry.

Money statement.

July 1, 1881, amount available	$4,437 51
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	3 06
July 1, 1882, amount available	4,434 45

J 14.

SURVEY FOR OPENING OF STEAMBOAT COMMUNICATION FROM THE SAINT JOHN'S RIVER, FLORIDA, BY WAY OF TOPOKALIJA LAKE, TO CHARLOTTE HARBOR OR PEACE CREEK.

UNITED STATES ENGINEER OFFICE,
New York, May 23, 1882.

GENERAL: Section 2 of the river and harbor act approved June 14, 1880, provided that the Secretary of War be directed to cause an examination or survey, or both, with estimates of cost, to be made for the opening of steamboat communication from the Saint John's River, Florida, by way of Topokalija Lake, to Charlotte Harbor or Peace Creek.

By department letter dated June 17, 1880, the work was assigned to my charge, and I have the honor to submit the following partial report thereon, which has been made as full as the limited means at my disposal would permit.

The general location of the lines to be examined or surveyed was indicated by the condition that Topokalija, or more correctly Tohopokeliga, Lake should constitute an integral part of the route, and the field work was planned and executed accordingly.

The great extent of country representing the site of the operations, the innumerable difficulties encountered in the wilderness of swamps, marshes, and prairies through which very many miles of the survey had to be run, and an almost total absence of any regular or organized means of communication, have intervened to prevent a thorough and in all respects satisfactory accomplishment of the object in view.

It is believed, however, that the leading object of the survey, which has been understood to be the determination of the feasibility, or otherwise, of a project for opening up steamboat communication between the points indicated in the act, has been fully attained.

Assistant Engineer G. Daubeney was originally selected to conduct the survey. He proceeded to Florida in December, 1880, where he was for some time engaged in examining the Upper Saint John's River, in procuring information necessary for deciding upon a detailed plan of operations, in obtaining numerous copies of township maps from the United States land office at Gainesville, Fla., and in making arrangements for transportation and supplies.

The first party took the field February 1, 1831, and another very soon thereafter.

During the month of March, 1881, Mr. Daubeney was relieved from his duties at his own request, and Mr. W. G. Williamson, of Lexington, Va., was appointed his successor. His assistants on the survey, in charge of parties, were Mr. J. F. Le Barron, Mr. J. Gartland, and Mr. R. Paulsen.

The field work was completed, so far as the funds allotted therefor would allow, in July, 1881.

Since the act providing for the survey explicitly states that the contemplated route should include Lake Tohopokeliga, the principal lines examined and surveyed were run so as to connect that lake with the eastern and western terminal points indicated in the act. Practically the operations extended from longitude 80° 48′ west to longitude 82° 15′ west, and from latitude 26° 30′ north to latitude 28° 30′ north.

Neither the terminal point of the route on the Saint John's River nor the draught and tonnage of steamboats to be accommodated had been indicated in the act. Mr. Daubeney's examination of that river from Lake Monroe to Lake Winder showed that although it was in some places only about 50 feet wide, it contained plenty of water for a sternwheel steamboat about 70 feet long, with 20 feet beam and drawing 3 feet of water. Assistant Williamson says of this reach that it is extremely crooked and in some places quite shoal, but thinks it capable of being made navigable for boats drawing from 4 to 5 feet of water. That section of the river between Lakes Poinsett and Winder was found to be as good in regard to navigation as any of the other reaches above Lake Harney, and since that section was nearest to the given intermediate point of the route, Lake Tohopokeliga, it was decided to run a transit and level line from that lake to either Lake Poinsett or Winder.

A line to Lake Poinsett was found to be impracticable for the passage of a team, which necessarily had to accompany a party carrying with it a quantity of provisions and other material. A transit and level line to Lake Winder was then chosen and successfully run.

The surface of Lake Winder was found to be at an elevation of 18.737 feet above the mean high-water level of the Gulf at the mouth of Peace Creek.

The eastern terminus of the line on that lake was located near Fort Taylor, at the mouth of Wolf Creek, township 26 south, range 35 east.

It was assumed that in order to comply fully with the requirements of the act of Congress it was necessary to determine whether a practicable route might be established by utilizing as portions of it the lakes between Tohopokeliga Lake and Upper Saint John's River, on the east side, and certain other lakes situated between Tohopokeliga Lake and Peace Creek on the west side.

It was likewise assumed that the act contemplated a water-route without locks, suitable for such steamboats as are able to ascend the Saint John's River as far as Lake Winder.

From the facts developed by the surveys and examinations of Mr. Williamson and his assistants the conclusion is reached that it is not practicable to establish a through route from the Saint John's River, by way of Tohopokeliga Lake, to Charlotte Harbor or Peace Creek, on the west coast of the Florida peninsula, without the employment of locks, except perhaps at a cost plainly unwarranted by the amount of traffic and the extent of population that would for many years to come be accommodated by it.

For convenience of description the route via Tohopokeliga Lake, as surveyed, will be considered as composed of three sections, to wit: An easterly section, from Lake Winder to Tohopokeliga Lake; a central section, from the last-named lake to Lake Kissimmee; and a westerly section from Lake Kissimmee west to Peace Creek, and following that creek down to its entrance into Charlotte Harbor. These different sections will be briefly reviewed.

EASTERLY SECTION.

There are two lakes of importance situated between the terminal points of this section that might be utilized either as parts of the route or as reservoirs for supplying it with water. They are Little Tohopokeliga Lake, with an area of 20.75 square miles of water surface, and Alligator Lake, having an area of 5.83 square miles. A small sheet of water, Lake Isabel, of about half a square mile area, lies between them. Tohopokeliga Lake extends over an area of about 26 square miles. At the time of the survey its water level was 45.86 feet above that of Lake Winder, and from 6 to 7 feet below that of the three intermediate lakes named, which are practically on the same level, the smallest lake being slightly the highest of the three.

By the transit and level line run from Lake Winder to the Lakes Tohopokeliga, by way of the intermediate lakes, the distance is 41.68 miles, and from the northeasterly point of Tohopokeliga Lake, the terminal point of the transit line, down the lake to the exit of Kissimmee River, 11.3 miles more, or an aggregate length of 52.98 miles from Lake Winder to the outflow of the river.

An open cut along such a route would result in draining the water of the three intermediate lakes and their tributary swamps into Tohopokeliga Lake, unless a lock is interposed between the two Tohopokeliga Lakes.

Assistant Williamson suggests, without recommending it, a shorter line by connecting Alligator Lake directly with Tohopokeliga Lake, but says that a lock would likewise be necessary between these two lakes.

A third scheme might consist in connecting Lake Winder by nearly a straight line with Tohopokeliga Lake near its southern end. The length of this line to the exit or head of Kissimmee River, at the south end of the last-named lake, would be about 32 miles, of which about 30 miles is in excavation.

Such a line, if locks could be dispensed with, would not be impossible in regard to the currents that would be produced in it during ordinary low-water stages. The difference of the elevation of the water level at the two ends of the cut is shown by the survey to be 45.856 feet, equal to a slope of .0002895, or 18.34 inches per mile.

With a normal cross-section of the canal of 40 feet width at bottom, 65 feet width at the water surface, and 5 feet depth, the mean velocity of the current would be about 2.577 feet per second, or 1¾ miles per hour, which would not be objectionable.

The volume of discharge, under such conditions, amounts to 676 cubic feet per second. During a month of thirty days the consumption of water, to maintain a depth of 5 feet in the cut, would amount to not less than 1,753,400,000 cubic feet, without estimating for losses by evaporation and filtration. Possibly there would be no loss from the latter source that would not be compensated by infiltration owing to the depth of the cut.

But a little calculation shows that during the dry season of the year the quantity of water required for keeping the open cut in navigable condition cannot be secured from the rainfall occurring in that time.

Observations in regard to rainfall have for several years been made at Punta Rassa, near the mouth of the Caloosahatchie, by the United States Signal Service, and the general data of these observations are appended to Assistant Williamson's report. In this part of the country the driest months of the year are generally February, March, and April. During these three months, in 1881, while the survey was in progress, the aggregate rainfall amounted to 2.24 inches. Allowing that one-third of this quantity could be drawn into the canal, it would require a drainage area of over 3,000 square miles to supply the canal with water if dependence be placed solely on the rainfall during the three months.

Such an area would be equal in extent to about eighty-four townships, and a glance at the map clearly shows that it would not be available.

Gates would therefore be needed at the several lakes serving as reservoirs for retaining the water collected during the rainy season, and for regulating the outflow; but even then the result would be doubtful and uncertain, for the following reasons:

Tohopokeliga Lake, together with the Little Tohopokeliga, Lake Isabel, and Alligator Lake, have an aggregate area of water surface of about 53 square miles. The area of the swamps, &c., tributary to these lakes is estimated at 250 square miles.

The evaporation at the water surface of the lakes may be estimated at three-tenths of an inch per day. Assuming the favorable case that at the swamps the daily evaporation amounts only in the aggregate to one-tenth of an inch, and supposing that a large proportion of the water sinks down low enough to escape evaporation, to appear subsequently as subterranean feed-water, it is found that during the eight months comprising the dry and the wet season of the year it would require a rainfall of about 52 inches to furnish the canal with water and provide for evaporation. But the observed rainfall at Punta Rassa in the rainy months from May to October, 1880, amounted only to 22.58 inches, which, added to the rainfall of 2.24 inches during the three dry months in the first part of the year 1881, gives an aggregate of only 24.82.

Assuming even that further investigations may show the probability of a more abundant water supply than seems to be possible under the circumstances, the great depths which a cut without locks would reach at many points are highly objectionable. At some places the line would pass over ground about 60 feet above Lake Winder, and the excavation would be over 45 feet deep. The average depth of the cut would probably be about 30 feet. With a berme 4 feet wide on each side of the canal, placed on the ordinary water level, and with side slopes above of 1¼ base to 1 in height, the aggregate amount of excavation needed on the eastern section would reach 12,000,000 cubic yards of material. It is impossible to form even an approximate estimate of the cost of such an undertaking without such a knowledge of the nature of the lower strata of the ground as could be furnished only by a comprehensive series of borings.

Another point deserves attention. It is a peculiar feature of the soil of Florida, owing to its sandy and generally nearly level surface, that a large portion of the rain-water is absorbed and sinks down into the ground.

The subsoil is a well-stocked receptacle and storage magazine of the rain-water thus absorbed, from which, by innumerable subterranean veins and rivulets, the lakes and ponds are fed. This condition is very favorable to the employment of the large lakes as natural reservoirs for a canal with locks, since the demand for water to operate such a canal would be moderate enough to cause no violent disturbance of the existing hydraulic relations. But an open and comparatively deep cut would soon cause a very active flow of these subterranean waters to its bed, which would probably be abundantly provided with water from that source for a certain length of time. But gradually the level of these subterranean waters will be lowered by the unceasing drain, the stock of stored-up water will become exhausted, and while the swamps may be reclaimed by the operation, their usefulness as direct or indirect feeding reservoirs to the canal will be destroyed or very materially impaired.

Moreover, a deep cut would act as a catch-basin for the flood waters for miles on each side during the rainy season, and carry them down to the Saint John's River, increasing the destructive effects of freshets in the valley of that river. The cut would actually be a great channel of drainage for the upper part of the eastern section, and would probably effect the reclamation of a very large area of swamp land which is now useless, but it would also drain off a vast amount of water which, if retained, would have been available for purposes of navigation during the dry season.

CENTRAL SECTION.

This part of the route comprises the Kissimmee River from its head or point of exit at the southern end of Tohopokeliga Lake down to Kissimmee Lake.

The river passes on its course through two lakes—Little Cypress Lake, with an area of 6 square miles, and Big Cypress Lake (Hatchinihaw), having an area of 18.38 square miles. It enters Kissimmee Lake at its northern end, near Fort Gardner. The southern terminal point of the line as surveyed is at or near the point where Tiger Creek enters Kissimmee Lake from the southwest, about 2⅔ miles south of the entrance of Kissimmee River into the lake. The whole length of this section, by river and lake, is about 25 miles, of which a portion 15.8 miles long forms the river route; the balance is lake route.

The total fall from end to end of this section was found to be 5.925 feet, Kissimmee Lake at the mouth of Tiger Creek being at an elevation of 39.931 feet above Lake Winder, and 58.668 feet above mean high-water in Charlotte Harbor.

The central section is entirely practicable for a steamboat line of communication without locks; in fact it has been used for some time past by a light-draught steamboat plying between Tohopokeliga Lake and Lake Okeechobee, into which Kissimmee River discharges. The river, however, requires to be improved at several points by widening and straightening. A uniform enlargement of the river to the dimensions assumed in discussing the eastern section would undoubtedly result in drawing off a larger volume of water from Tohopokeliga Lake than heretofore, and would render an ample supply of water for an open cut in the eastern section still more precarious.

WESTERLY SECTION.

The western branch of the route surveyed begins on the west side of Kissimmee Lake, at the mouth of Tiger Creek.

Going westward, a number of lakes are met with. They are named as follows, in the order from east to west:

Tiger Lake (or Lake Kot-sa);
Lake Walk-in the-water (or We-oh-ya-rap-kah);
Lake Lenoir;
Little Tiger Lake;
Crooked Lake (Oh-kah shay-kon-hee);
Lake Buffum.

Every successive lake, going in a westerly direction, is higher than the preceding one; Lake Buffum, the most westerly one and nearest to Peace Creek, being the summit or highest lake of all. Its water level was found to be 79.597 feet above Kissimmee Lake, 73.672 feet above Tohopokeliga Lake, 119.528 feet above Lake Winder, and 138.265 feet above mean high-water of the Gulf.

The distance from Kissimmee Lake to Lake Buffum by the line surveyed is 26.57 miles In a straight line it would measure about 21 miles.

On this line the ridge that traverses the peninsula of Florida from north to south was crossed.

The summit point was found between Little Tiger Lake and Crooked Lake, about 16½ miles southwest from the initial point on Kissimmee Lake. This point is at an elevation of 163.257 feet above the Gulf and about 25 feet above Lake Buffum.

Between Lake Buffum and Fort Meade, on Peace Creek, high sand hills exist; for which reason the line of survey followed Bowlegs Creek, the outlet of Lake Buffum, to its junction with Peace Creek, 2.8 miles below Fort Meade. On the length of about 15 miles, from Lake Buffum to its mouth, Bowlegs Creek falls 65.125 feet. From the junction to the mouth of Peace Creek, at Charlotte Harbor, the length of that river is 95.36 miles.

It will be evident from this brief description that a number of locks would be necessary on the line from Kissimmee Lake to Peace Creek; indeed, a mere glance at the longitudinal profile shows that they are indispensable.

It was thought advisable to ascertain whether Peace Creek could be reached more conveniently by following the creek named Big Charleypopka, its most important tributary from the east.

A transit and level line was run from Lake Lockapopka (about 1 mile southeast of Crooked Lake; elevation above the Gulf, 116.63 feet), in a southerly direction to the headwaters of the Charleypopka, passing the highest ridge or divides, 134 feet above the Gulf level, about 9 miles south of Lake Lockapopka. The survey then followed Big Charleypopka to its entrance into Peace Creek, about 51½ miles from the mouth of the latter, and 47¾ miles below Fort Meade.

It was found that the Big Charleypopka was generally too narrow and crooked to be navigated, even during flood stages, except perhaps by straightening and deepening it at great expense, especially since lime rock and rotten sand rock were found to exist at several places, either in the bed of the creek or in its vicinity. At low-water it would afford no navigation for lack of water.

Peace Creek was examined from Fort Meade to its mouth by means of an instrumental boat survey. The total length, by stadia measurement, was found to be 98.196 miles; in a straight line it would only be about 55 miles.

The principal obstructions to navigation, besides its great tortuousness, especially in the upper portion, are thousands of snags and leaning trees and numerous sand and rock shoals.

During high stages of the water light-draught steamers might ascend the creek to Fort Meade if the snags and leaning trees were removed, but to render it navigable during the dry season the lock and dam system would most probably be required.

It is quite clear that a steamboat route without locks from the Saint John's River to Peace Creek, on the route designated by Congress, is not practicable on account of the obstacles met with on the eastern and western sections.

An alternative project was thought of, but the necessary survey or examination was not completed; moreover, by that project only the western section would have been modified, while the eastern section would still have formed a part of it.

This project consisted in continuing the central section further south through Kissimmee Lake and down Kissimmee River to Lake Okeechobee, and through that lake, by way of the Caloosahatchie, to San Carlos Bay.

It is true that the act of Congress names Peace Creek or Charlotte Harbor as the western terminal points of the route; but since San Carlos Bay is connected with Charlotte Harbor by Pine Island Sound and Matlacha Pass, it was assumed that this route would perhaps come within the meaning of the act.

On this assumption it can scarcely be doubted that such a route would represent a solution of the problem, provided the eastern section as described were entirely practicable. Kissimmee River is now navigable for small steamboats, although it requires a good deal of improvement in the way of straightening and otherwise correcting its course, and there is no question about sufficient depth in Okeechobee Lake, except near its banks.

Kissimmee River was cursorily examined as far down as Fort Kissimmee, a few miles below the boundary line of Polk and Brevard counties.

A rapid reconnaissance only could be made of the Caloosahatchie, from its mouth to its headwaters in Lake Hikpochee, a few miles west of Okeechobee Lake.

Hikpochee Lake is undoubtedly fed from Okeechobee, but an uncommonly dense growth of very tall saw-grass has repeatedly foiled the attempts of parties to pass through. It also happened that the examining party had to be recalled just at that juncture because the funds were nearly exhausted.

The total length of the Caloosahatchie is estimated at about 65 miles. No levels could be taken on this examination. From the report made to Capt. A. N. Damrell, United States Engineers, by Mr. J. L. Meigs, who examined the river, and ran a line of levels from Lake Hikpochee to low-water at Fort Myers (see Annual Report of the Chief of Engineers, 1879), it appears that the aggregate fall in that distance was 21.94 feet. He could not penetrate the Okeechobee Lake, but assumed it to be on the same level with Lake Hikpochee. It is said that a recent leveling operation executed by a private company has shown Okeechobee Lake to be about 2½ feet higher than Lake Hikpochee, a difference of level that seems to be rather excessive.

At times of flood large volumes of water pour through the belt of saw-grass from Okeechobee Lake to Lake Hikpochee and down the Caloosahatchie to the Gulf. At such times the river is subject to excessive and long-continued overflows, and many settlements, especially between Fort Meyers and Fort Thompson, have been abandoned for that reason.

From Lake Hikpochee down, the river was found to flow in many channels through tall saw-grass and other aquatic plants to Lake Flirt, a large expanse of water filled with lilies and grass, and with several channels through it. From that place the river is clearer, gradually increasing in width from 100 feet upward.

The Caloosahatchie assumes the character of an estuary of the Gulf some miles above Fort Myers.

As a preliminary improvement of the river, the removal of numerous snags and leaning trees below Fort Thompson, and of a few shoals, notably Beautiful Island Shoal, would doubtless be necessary. But a more comprehensive regulation of its course would consist in cutting a wide and deep channel through the saw-grass marsh between Lakes Hikpochee and Okeechobee, and extending it to and below Lake Flirt, as well as deepening and otherwise regulating the course of the river lower down to accommodate an increased flow of water.

It was not thought expedient to prepare an estimate of the probable cost of a permanent and thorough improvement of the Calooshatchie, inasmuch as a regular survey of the river should be made first, and the whole question requires further study. In its improved condition the river would act at all seasons of the year as the great channel of drainage of Okeechobee Lake. At the same time its depth, area of cross-section, and slope should be so managed as to keep the river within its banks, prevent the recurrence of disastrous overflows, and render the rich and productive lands adjoining the banks attractive to settlers.

It may not be impossible to establish a steamboat route without locks from the Saint John's River to Charlotte Harbor, but not by way of Tohopokeliga Lake. The easterly section should be placed farther south.

From the information obtained by Assistants Williamson and Le Baron, a canal without locks can possibly be cut from the headwaters of the Saint John's River, south of Lake Washington, to the northern end of Okeechobee Lake.

The length of the cut would be about 48 miles, three-fourths of which would be through morasses so boggy that the surveyors of the United States Land Office have been unable to penetrate them to subdivide them, pronouncing them impassable.

Either Taylor's or Cow Creek, both tributaries of Okeechobee Lake, might be improved and form the southern portion of the eastern section.

Nearly the whole tract of land to be traversed by such a cut is said to be usually covered with from two to four feet of water during the rainy season; from which it may be concluded that the land is generally low and level.

The difference of elevation between the two terminal points of this section is not known; it is believed to be small. According to the levels taken at the recent survey, Lake Winder is 18.74 feet above high-water at Charlotte Harbor, where the mean rise and fall of tides is 1.7 feet. Assistant Meigs, during his examination of the Caloosahatchie, found Lake Hikpochee 21.94 feet above low-water at Fort Myers. Assuming the same amount of rise and fall of tides to exist at the mouth of Peace Creek as at Fort Myers, and that Lake Hikpochee is on the same level with Okeechobee Lake, the water surface of the latter is 20.24 feet above high-water of Charlotte Harbor, and 1.5 feet above that of Lake Winder.

Some idea may be formed of the probable elevation of Lake Washington and of the headwaters of the Saint John's River by referring to the survey of a canal route from the Saint John's River to Espiritu Santa Bay (Tampa Bay), made by Lieut. L. M. Smith, United States Topographical Engineers. Extracts of his report dated May 1, 1855, are reprinted in the Annual Report of the Chief of Engineers, 1876. The eastern terminal point of the route recommended by Lieutenant Smith was located at the entrance of the Weekivah into the Saint John's River, about 4 miles below Lake Monroe; the western end at the mouth of Hillsboro' River, at the north end of Hillsboro' Bay, a branch of Tampa Bay. He reports the water-level of the Saint John's River at the point indicated to be 12 feet above low-water of Tampa Bay, where the mean rise and fall of tides is 1.4 feet, according to the Coast Survey chart of 1876. At the mouth of the Weekivah, Saint John's River is, therefore, 10.6 feet above high-water of the Gulf, the datum to which the levels of last year's survey have been reduced.

Lake Winder is 18.74 feet above high-water of the Gulf; consequently there must be a fall of 8.14 feet from that lake to the mouth of the Weekivah, a distance by river estimated at 90 miles, more or less. From Lake Winder to the headwaters of the Saint John's River it is about 30 miles. If we assume a similar slope of the water-surface of the river on that reach, the headwaters will be about 21.45 feet above the Gulf, or 1.21 feet above Okeechobee Lake. They may be somewhat higher, but in a length of cut of 48 miles a fall of a few feet will not signify. The necessity of a lock is not entirely excluded, however, to prevent a drainage of the swamps feeding the headwaters of the Saint John's River in the direction of Okeechobee Lake, producing possibly a scarcity of water in the upper reach of that river.

The plan of the through route would therefore be simply as follows: A cut from the headwaters of the Saint John's River to Okeechobee Lake, utilizing either Taylor's Creek or Cow Creek, and then through the lake to the Gulf by way of the Caloosahatchie.

It must be admitted that little or nothing is known authentically of the condition of the Upper Saint John's from Lake Winder to the headwaters; that it would probably require a considerable amount of work in straightening its course and in widening and deepening its bed; that after enlarging it to suitable dimensions we are not assured that enough water will find its way into it from the adjacent swamps to preserve it at its minimum depth during the dry season without going to the expense of cutting a number of long lateral drains to convey to the improved river the necessary water from more distant parts; and that the number of lakes through which the river naturally passes is increased in regard to the route suggested, tapping the river at its headwaters, every one of which lakes will probably have a bar at the river's inlet requiring special works for their improvement. The higher up on the river the initial point of the water route is taken, the more will the draught of vessels be reduced that can ascend to that point. There is a limit to the amount of water that can be supplied to the improved river from available sources. The question may be said to stand as follows: While a route without locks is probably feasible when starting from the headwaters of the Saint Johns or from Lake Washington, it can be used only by boats of very light draught, while by starting from points lower down vessels of greater draught can be accommodated by a canal with locks.

Another feasible line may be found, running from Kissimmee River to the Upper Saint John's River, by way of Lake Marianna; considering the Lower Kissimmee River as a part of the route and retaining Okeechobee Lake and the Caloosahatchie. Most probably, however, such a line would require locks, though, perhaps, only a few.

Assistant Le Baron suggests as not improbable a steamboat route by way of Trout-eating Creek (Tsalapopkahatchie) from the mouth of Peace Creek to the headwaters of Fisheating Creek (Tlathahopkahatchie), a tributary of Okeechobee Lake; thence through some intermediate lake to Great Istokpoga Lake and to Kissimmee River, and thence to the headwaters of the Saint John's River. Nothing whatever is known as to the possibilities of this route; the chances are that locks are necessary as well as considerable excavation.

It is thought that if a route from the Saint John's River to Charlotte Harbor be established, it should not only accommodate through traffic, but should also promote the development of a wide strip of land adjoining its bank, to secure transportation of produce and merchandise from and to intermediate points on the line. For that purpose, it seems, the route should serve as a means of preventing destructive overflows during the rainy season, so that settlers may not have their cultivated lands desolated by floods. An open cut of sufficient dimensions, without locks, and with an adequate slope of its water-surface, will most securely draw off the flood waters; but there will be more or less uncertainty about the navigability of the canal in dry weather. A canal with locks can be relied on, if properly located, to have a sufficiency of water during the dry months. In proportion, however, as its level reaches between the locks operate to prevent a rapid draining off of the surplus water in the rainy season the settled districts along its banks would be threatened by inundation. In such cases the lock-gates might be opened to let the superabundant flood water escape; but the operation would require careful management to prevent the loss of storage water needed during the dry season. These antagonistic relations make the problem sufficiently complicated.

APPROXIMATE ESTIMATE OF THE COST OF A STEAMBOAT ROUTE WITH LOCKS FROM THE SAINT JOHN'S RIVER TO PEACE CREEK OR CHARLOTTE HARBOR, BY WAY OF TOHOPOKELIGA LAKE.

The canal is supposed to have a width of 40 feet at the bottom and 5 feet depth of water, as already indicated. The locks to be 25 feet wide with 125 feet useful length and an average lift of 8 feet.

The estimate is necessarily only a rough approximation, since the Saint John's River, which has to be improved from Lake George to Lake Winder, a distance of 70 miles, was only superficially examined, and Peace Creek has not yet been regularly surveyed; moreover, only a small part of the canal sections of the route upon which the estimates are based is assumed to be located exactly upon any one of the lines run, varying more or less therefore, and not always in the interests of diminished cost.

The Saint John's River, which from Lake George to Lake Winder is used as an easterly approach to the canal, is very crooked in many places, but otherwise generally well suited to such boats as will be able to pass through the canal. From the similarity of this reach of the river to that from Lake Monroe to Lake George, examined and partially surveyed under my direction in March, 1879, it is estimated that it can be straightened and otherwise improved, wherever improvement is necessary, for the sum of $120,000.

For convenience of description the route westward from Saint John's River will be divided into three sections, namely, an eastern section, a central section, and a western section.

1. EASTERN SECTION.

It has been considered expedient not to depend on Tohopokeliga Lake at all for water supply, but leave it as a reservoir for feeding the improved Kissimmee River.

Little Tohopokeliga Lake, Lake Isabel, and Alligator Lake, all of them nearly of the same elevation—about 53 feet above Lake Winder—with the cuts connecting them, constitute the summit level of the section. Probably the lake in Jug Creek Bay may also form a part of this level; its elevation was not taken, but there are indications that it is nearly the same height as Alligator Lake.

The spacious lake north of Alligator Lake and several ponds in the vicinity would form part of the system as auxiliary reservoirs.

These various lakes have an aggregate area of water surface of about 32 square miles. They will, with the surrounding swamps, amply provide the required amount of water.

In the estimate it is assumed that the chain of lakes, from the lake in Jug Creek Bay to Little Tohopokeliga Lake, are connected by open cuts. From Jug Creek Bay to Lake Winder, a distance of 15.7 miles by canal, seven locks will be needed. From Little Tohopokeliga to Tohopokeliga Lake the distance is 4 miles, and one lock is required.

The aggregate length of the eastern section is estimated at 34 miles, to wit:

	Miles.
By canal proper	19.7
By open cuts	6.3
By lakes	8.0
	34.0

Feeders from auxiliary reservoirs may have an aggregate length of 5 miles; they are to be of ample width, say 30 feet at bottom, and will average about 10 feet in depth of cut.

The depth of cut of the canal will average 11½ feet; the maximum depth is about 18 feet, except in one place, where it will be about 25 feet.

The aggregate amount of excavation for canal and feeders is computed at 4,500,000 cubic yards. It will probably be generally easy digging, but as in the deeper cuts more resisting strata may be met with, about 1,000,000 cubic yards are estimated to cost 50 cents a yard, and the balance 25 cents.

Excavation and embankment:	
3,500,000 cubic yards, at 25 cents	$875,000
1,000,000 cubic yards, at 50 cents	500,000
Clearing and grubbing 26 miles of canal, at $1,000	26,000
Clearing and grubbing 5 miles of feeders, at $500	2,500
8 lift locks, at $30,000	240,000
Waste weirs and gates for feeders	12,000
Works at the lakes at the end of line	35,000
Cost of eastern section	1,690,500

2. CENTRAL SECTION.

This section is considered to extend from the northern end of Tohopokeliga Lake, by way of Kissimmee River, to the mouth of Tiger Creek, on Kissimmee Lake.

By this route Tohopokeliga Lake and the most northerly part of Kissimmee Lake, as well as the intermediate lakes, are utilized.

The total length of the section is about 36½ miles, of which an aggregate length of 16 miles is river, while 20½ miles of the line passes through lakes.

The lakes are believed to possess sufficient depth for vessels that would use the canal. The river, although generally deep enough, requires considerable widening and straightening at many places. Bars may also form at the entrances of the improved river into the several lakes, requiring special works at these points.

The work to be done on this section will consist chiefly in dredging and in improving the entrances into the lakes.

300,000 cubic yards dredging, at 20 cents	$60,000
Improving three lake entrances, at $15,000	45,000
Grubbing, &c	10,000
Cost of central section	115,000

3. WESTERN SECTION.

This section is divided into two parts or divisions.

The first division extends from Kissimmee Lake to Peace Creek; the second division comprises Peace Creek itself.

First division of western section.

It is not deemed advisable to include Crooked Lake and Lake Buffum directly in the line of canal, owing to their great elevation above Kissimmee Lake, necessitating a greater number of locks. Moreover, they are not expected, from their high position, to command a large area of swamps and marshes, and they could not be relied on to furnish enough water for the summit-level of the canal.

For this reason Lake Lockapopka is selected as the summit lake, but it would be connected with Crooked Lake to render the latter available as a supply basin.

Eastward the line of canal would run from Lockapopka through Reedy Lake, Lake Walk-in-the-Water, and Tiger Lake to Kissimmee Lake. Seven locks would be required on this line, four of them on the short reach from Lake Lockapopka to Reedy Lake, which is 32.25 feet below the first-named lake; two locks between Reedy Lake and Lake Walk-in-the-Water (difference of level 16.44 feet); and one lock between the latter lake and Tiger Lake, with a fall of 8.5 feet. From Tiger Lake to Kissimmee Lake there is a fall of about seven-tenths of a foot in a distance of 2 miles. The work would here consist in improving Tiger Creek, which connects the two lakes. Lake Rosalie, which is somewhat higher than Tiger Lake, will be used as a feeding reservoir to the latter lake.

Westward of Lake Lockapopka a cut is proposed to connect the lake with Bowlegs Creek, at a point some 5 or 6 miles below its head, or the south end of Lake Buffum. The point would be selected with a view of having but little slope in the water surface of the proposed cut—less than a foot in length of about 7 miles. To control the water supply in the cut a lock will be placed at the upper end, near the lake.

From the point just indicated it is proposed to follow Bowlegs Creek down to its debouché into Peace Creek, a length of about 10¼ miles, with a fall of about 43 feet.

Bowlegs Creek is a narrow stream, not above 30 feet in width, with about 18 inches of water during the dry season, increasing to from 3 to 5 feet near its mouth. The creek requires widening and deepening, and, at some places, straightening. A better supply of water will be secured by the cut connecting the creek with Lake Lockapopka, and by transforming its upper reach into a feeder from Lake Buffum. But in addition to this the creek must be canalized, else its great slope would prevent the formation of suitable depths and widths.

Ten locks and dams are estimated to be required in Bowlegs Creek. As there is an abundance of good pine timber close by, it is proposed to build crib dams, and use timber extensively in constructing the locks. A substantial lock will be placed at the juncture with Peace Creek.

The length of the first division would be about 38¾ miles, of which there would be 16½ miles by canal, 12 miles by lakes, and 10¼ miles by canalized creek.

With the disposition here described we may be assured of an ample water supply. But in order to reach Peace Creek we cannot avoid crossing the Florida Ridge, between Lake Lockapopka and Bowlegs Creek.

The average depth of cut between these points, on a length of 7 miles, will be 27 feet, with a maximum depth of about 40 feet.

COST OF FIRST DIVISION, WESTERN SECTION.

a. East of Lake Lockapopka:

3,850,000 cubic yards excavation for canal, at 25 cents	$962.500
900,000 cubic yards excavation for canal, at 50 cents	450,000
150,000 cubic yards excavation for feeders, at 20 cents	30,000
60,000 cubic yards excavation for feeders, at 40 cents	24,000
Grubbing and clearing 16½ miles canal, at $1,000	16,500
Grubbing and clearing 2½ miles feeders, at $500	1,250
Waste weirs, gates for feeders, &c	10,000
8 locks, at $30,000	240,000
Works at Kissimmee Lake	20,000
	1,754,250

b. West of Lake Lockapopka:

100,000 cubic yards excavation or dredging, at 20 cents	$20,000
20,000 cubic yards embankment (borrowed), at 40 cents	8,000
10 locks and dams, at $16,000	160,000
1 lock at junction, Peace Creek	30,000
	218,000
Total first division, western section	1,972,250

Second division of western section.

The total length of Peace Creek, from Fort Meade to Charlotte Harbor, is about 100 miles, but the distance is only 55 miles in a straight line.

The river is therefore very tortuous, especially in its upper reaches. During the dry season it is too shallow at many places for any kind of navigation. The bottom of the bed is generally sand and mud; but sticky clay and rock are also found.

The information gained by the boat survey of last year will scarcely suffice as the basis of a reliable project for improving Peace Creek to such extent as to render it navigable all the year round for steamboats drawing from 3 to 4 feet of water.

While it is thought that the following-named works of improvement may be required, the estimate should be regarded as a very crude approximation only, subject doubtless to material modifications, when a thorough examination shall have been made.

COST OF SECOND DIVISION.

Straightening Peace Creek	$100,000
Removing 3,500 snags, at $10	35,000
Removing 4,000 leaning trees, at $2	8,000
Removing sand shoals, 300,000 cubic yards, at 30 cents	90,000
Removing soft rock shoals, 150,000 cubic yards, at 60 cents	90,000
15 locks and dams, at $20,000	300,000
Total second division, western section	623,000

The total estimated cost, therefore, of building a canal with locks, on the line indicated, giving a navigable depth of 5 feet, including 25 per centum for contingent expenses and $12,000 for additional surveys, is $5,662,812, or in round numbers, $5,700,000, to wit:

Improving Saint John's River	$120,000
Eastern section of steamboat route	1,690,500
Central section of steamboat route	115,000
Western section of steamboat route	2,595.250
25 per cent. for contingencies	1,130.062
Additional surveys	12,000
Total	5,662,812

No estimate is submitted for the alternative project, referred to in this report, which consists in retaining the eastern section above described, and continuing the central section by the Kissimmee River to Okeechobee Lake, and through that lake by way of the Caloosahatchie to the Gulf.

All that is known of Kissimmee River is that it can be navigated by steamboats of very light draught, and that it is extremely tortuous, and that during the rainy season its banks are overflowed, inundating immense tracts of adjacent land. Okeechobee Lake in its present condition would undoubtedly be navigable for boats drawing from 3 to 4 feet of water. It is vaguely reported, on unknown authority, that its depth nowhere exceeds 12 to 14 feet. The lake has really never been surveyed—a circumstance partly due to its remoteness from the lines of commerce, and partly to the inaccessibility of its shores.

Attempts, to be briefly referred to further on, are now being made to drain this lake, or to lower very considerably the level of its water surface. Such an operation, when accomplished, would materially affect any project for constructing a steamboat route in that direction that could now be made.

As to the Caloosahatchie, it has been already stated in this report that a well digested plan for its thorough and permanent improvement cannot be formed before it has been regularly surveyed.

All that may now be said in regard to this route, by way of Okeechobee Lake, is that it can probably be established at less cost than that by way of Peace Creek.

On the other hand, there can be no doubt that the approach from the Gulf to the mouth of Peace Creek, through Boca Grande and Charlotte Harbor, the route evidently contemplated in the act under which the recent examination was made, is much more direct and affords better water than the circuitous approach to the mouth of the Caloosahatchie by way of Boca Grande, Pine Island Sound, and San Carlos Bay, which would naturally form a part of the alternative line above described.

There can be no doubt that a navigable route from the Saint John's River to Charlotte Harbor would form a prominent and important feature in any scheme contemplating the development of Southern Florida. It is known that tropical and semi-tropical products and fruits and marketable vegetables of many kinds, and of excellent quality, can be raised here at a profit in abundance, and that extensive and valuable timber land exists in this region. Large tracts of very rich and productive soil would be rendered accessible to settlers by a suitable water-route, and vast areas of perhaps not less valuable land would doubtless be reclaimed by the construction of a canal.

Much activity has of late years been shown in the development of the railroad system in Florida, with an evident tendency of extending it southward. The South Florida Railroad, from Sanford on Lake Monroe to Orlando, has lately been extended to Kissimmee City, at the north end of Tohopokeliga Lake. A south branch of the Atlantic, Gulf and West India Transit Railroad now reaches Ocala and is designed to connect with Tampa Bay.

Several lines of railroad are projected to run southward, notably one line proposed to run all along the eastern coast of Florida as far south as Saint Lucie at Indian River Inlet, and several lines are designed to reach Charlotte Harbor; other lines are to be constructed for transit across the State from east to west.

A company has lately been chartered by special act of the legislature of the State of Florida for the purpose of purchasing and improving certain tracts of land in Florida, the building of canals and other lines of transportation, and for other business. It has a concession for the reclamation of all the land lying south of townships twenty-four and east of Peace Creek. This vast tract of land embraces all the territory covered by the recent survey, except Peace Creek and the Lower Caloosahatchie.

The company proposes to open channels from Okeechobee Lake to the Saint Lucie River on the east and to the Caloosahatchie on the west, not only for the purpose of permanently lowering the water level of the lake and reclaiming a large area of land thereby, but also to secure means of transportation for the products of the Kissimmee Valley and the surrounding country. They have likewise, it is claimed, acquired the franchise for constructing canals for navigation, connecting the Saint John's River near its mouth, by way of Pablo Creek, with all the rivers, lakes, and lagoons situated on and parallel to the east coast of Florida, as far south as Lake Worth.

From information lately obtained they have been for some time dredging in the Caloosahatchie, and have almost reached Lake Hikpochee. A powerful steam dredge is said to have been built on Tohopokeliga Lake to open cuts down to Kissimmee Lake, and another cut to connect Tohopokeliga Lake with Little Tohopokeliga Lake, expecting thereby to reclaim many thousands of acres of swamp-land for agricultural uses.

I view of this private enterprise, which may be followed by others, it might perhaps be well to await the development of these schemes, before the general government takes further steps in regard to the establishment of a steamboat route across Southern Florida.

If it should be desired by Congress that further investigations be made with a view of more definitely settling the questions of the feasibility and cost of such a route, it is recommended that the following lines should be regularly surveyed:

1. A through line from Lake Poinset to the headwaters of the Saint John's River; thence to Taylor's Creek, or Cow Creek, through Okeechobee Lake, and down the Caloosahatchie to its mouth.
2. A check line from a convenient point of the first line to the Atlantic Ocean.
3. A line from Lake Washington via Lake Marianna to Kissimmee Lake, down Kissimmee River to a point about 50 miles below Fort Kissimmee, thence across to Istokpoga Lake to the head of Fisheating Creek, and to the mouth of Peace Creek via Trouteating Creek.

The cost of these operations, including a number of borings and diggings and miscellaneous examinations, is estimated at $25,000.

It may be remarked that it will be much less difficult to find a suitable line with a limited number of locks than one without any locks; and that a few locks cannot be considered as causing a serious obstruction to navigation by delay, on a canal that may have a length of from 150 to 200 miles.

The northern part of the route surveyed is located in the collection district of Jacksonville, Fla., the southern part in the collection district of Key West, Fla. Statistics furnished by the collectors at these ports are given in Assistant Williamson's report.

Besides a general map showing the lines surveyed or examined, and proposed to be surveyed if an appropriation should be made for that purpose, special sheets are forwarded showing plans and longitudinal sections of the lines run east of Tohopokeliga Lake, and immediately west of Kissimmee Lake, and referred to in this report, showing the impracticability of a water route without locks in that section of the country.

The following papers are transmitted herewith:

1. Report of Assistant W. G. Williamson.
2. General map showing lines examined.
3. Map and profile of survey from Lake Winder to Tohopokeliga Lake.
4. Map and profile of survey from Kissimmee Lake to Peace Creek.

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Lieutenant-Colonel of Engineers,
Bvt. Maj. Gen., U. S. A.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. W. G. WILLIAMSON, ASSISTANT ENGINEER.

RICHMOND, VA., *April*, 1882.

GENERAL: I have the honor to submit the following report of the survey "for the opening of steamboat communication from Saint John's River, Florida, by way of Tohopokeliga Lake to Charlotte Harbor or Peace Creek."

Mr. George Daubeney, who had been selected to conduct the survey, having lost his father, resigned, and by your order I relieved him on the 19th of March, 1881, at Orlando, Fla. He then turned over to me his instructions, and the two field parties, with their equipments."

The first party, under Mr. John Gartland, had been in the field some time (I think about twenty-eight days). The other party, under Mr. J. Fras. Le Baron, was on its way to Lockapopka, the point at which the survey intrusted to it was to commence.

The first party had finished a line from Alligator Lake to Lake Winder, and also lines connecting Alligator Lake with Lakes Isabel, Little Tohopokeliga, and Tohopokeliga, and was engaged running a line of levels from Tohopokeliga Lake to Lake Kissimmee below Fort Gardner. After reaching the Kissimmee this party was to continue its line to the mouth of Tiger Creek, thence by a chain of lakes and creeks to Peace Creek at or near Fort Meade.

The line to be run by the second party, as directed by Mr. Daubeney, was to commence at Lockapopka, and run by a chain of lakes to the head of Big Charleypopka Creek; thence, via the latter creek, to Peace Creek. The same party was also directed to examine Peace Creek to its entrance into Charlotte Harbor. Both parties were allowed to continue their lines until I could overtake them, and examine the country with a view to ascertaining whether any changes in Mr. Daubeney's order were necessary.

As soon as I learned from Mr. Daubeney his ideas, and acquired the information he had obtained, I made arrangements to go down the Kissimmee River in a boat.

Starting at the head of Tohopokeliga Lake, I left Orlando on the 25th of March, and, taking a small boat, with three men, I examined the Tohopokeliga Lake, the Kissimmee River connecting it with Little Cypress Lake, the Little Cypress, and the Kissimmee River connecting the latter with Lake Cypress, or Hatchinneeha. I then examined Hatchinneeha and the Kissimmee River below it as far as Fort Gardner. At Fort Gardner I joined Mr. Gartland's party, spent a few days with him, and then went to look up Mr. Le Baron's party. After giving both parties instructions, I returned to Orlando for the purpose of mailing my pay-rolls and getting funds to pay the parties for the month of March.

Returning to Fort Gardner, I continued my examination of the Kissimmee River and the Kissimmee Lake as far as Fort Kissimmee, where the road from Fort Meade to Fort Drum crosses the river. I was obliged to stop my reconnaissance here, as both parties needed money, and the men were becoming dissatisfied. There was no way of communicating with the parties, except by traveling in carts or on horseback, and this necessitated two or three weeks' travel.

I directed Mr. Gartland to continue his line from the mouth of Tiger Creek, via Tiger Lake, We-shy-a-kapa-oha-kon-kon-hee, Lake Buffum, and Bowlegs Creek, to Peace Creek, about 2½ miles below Fort Meade, as I found a direct line from Lake Buffum to Fort Meade would pass over high sand-hills, and be entirely impracticable. I changed Mr. Le Baron's orders so as to dispense with lines connecting Istokpoga Lake, and a chain of small lakes northwest of it, with the Big Charleypopka Creek.

Mr. Gartland was directed to connect his levels with those of Mr. Le Baron, at Lockapopka.

As soon as Mr. Gartland finished his line, and ran the levels from the mouth of Bowlegs Creek to Fort Meade, establishing a "bench-mark" there, his party was disbanded and he was ordered to New York to make his maps and profiles.

Mr. Le Baron had not finished his line, and I hoped to be able to take his party from the mouth of Peace Creek, through Charlotte Harbor, up the Caloosahatchie, and into Okeechobee Lake; thence to the head of the Saint John's River, as my observation of the country east of the Kissimmee, as well as information obtained from citizens familiar with it, led me to believe that the lowest ground between the Saint John's River and the Kissimmee, or Okeechobee, was either via Taylor's or Cow Creeks, across the ridge upon which Fort Drum is situated.

The appropriation was so nearly exhausted by the time this party had reached Lake Flirt, on the Caloosahatchie, that I was obliged to recall it.

As a canal with locks was not contemplated, but a through cut from the Saint John's to Charlotte Harbor, or Peace Creek, via Tohopokeliga Lake, the surveys which had been made were sufficient to prove the undertaking impracticable. The lines referred to connected the Saint John's with both Peace Creek and Charlotte Harbor, via Tohopokeliga Lake, which fulfilled the requirements of the act, and the information obtained, as well as my personal observation of the country south of these lines, convinced me that the only remaining line was by the Caloosahatchie River.

Mr. Meigs's survey in 1879 demonstrated that locks would be required to reach the Okeechobee from Charlotte Harbor by way of the Caloosahatchie. He found Lake Hikpochee 21.94 feet above mean low-tide at Fort Myers. He thought this lake on the same level as Okeechobee. We may rest assured it is not higher, and there can be no doubt that it will require locks to overcome this difference of level, especially at low-water, unless we intended cutting from the Atlantic to the Gulf a clear cut, regardless of expense.

But I am discussing a "steamboat route," and not a canal.

I will now show, by reference to the maps and profiles, that a route without locks, via Tohopokeliga, is impracticable.

Commencing at Lake Winder, the present terminus of steamboat navigation on the Saint John's River near Fort Taylor and Hardie's store, at an elevation by our levels above high-tide at Charlotte Harbor of 18,737 feet, the line skirts the lake until it strikes Wolf Creek, which it follows to its head, a distance of 10.11 miles, reaching an elevation of 61,989 feet, or 43.25 feet above Lake Winder, an average rise of 4.27 feet per mile. From the head of Wolf Creek it passes through cypress swamps and low-lying grounds to Alligator Lake, 16.94 miles; and this lake we find 9.49 feet above the head of Wolf Creek, and 52.74 feet above Lake Winder.

At points between Alligator Lake and the head of Wolf Creek the ground is 60 odd feet above Lake Winder. From Alligator Lake two lines were run to Tohopokeliga Lake, one via Lake Isabel and Little Tohopokeliga, and another more direct and nearly west to the lower end of Tohopokeliga, which is 45.85 feet above Lake Winder and 64.593 above Charlotte Harbor. By the first and most northern line through Isabel Lake, the distance is as follows: Across Alligator Lake, 1.35 miles; thence to Isabel, 2.01 miles, which may be reduced to 0.8 mile; across Isabel, 1 mile; from Isabel to Little Tohopokeliga, 1.11 miles; across Little Tohopokeliga, 4.8 miles; from Little Tohopokeliga to Tohopokeliga, 4.36 miles, which may be reduced by following Cross Prairies Creek to 3.6 miles. We have then the distance from Lake Winder by the line to Tohopokeliga Lake, 41.68 miles, which may be reduced by more direct routes over lower grounds to 39.71 miles.

Lakes Isabel, Little Tohopokeliga, and Alligator are so nearly the same level that they might be connected and used as a summit level.

The fall from Little to Big Tohopokeliga is 6.21 feet. The ground between Alligator and Tohopokeliga, via Isabel and Little Tohopokeliga, presents no difficulties to connecting these lakes, in fact Cross Prairies Creek connects the two Tohopokeligas now, and might be easily dredged and cleared of lilies and bonnets, so as to give from 5 to 8 feet navigation. If, however, the other lakes should be used as a summit level, it would become necessary to put a lock between Little and Big Tohopokeliga.

The other and more direct route referred to from Alligator Lake west to Tohopokeliga passes over higher ground a distance of 4.85 miles, and a canal would necessitate an average cut of not less than 18 feet, but it would save 9.61 miles in distance over the reduced route and 14.28 miles over the line as run via of Isabel and Little Tohopokeliga. By putting a lock at the entrance of the canal to Tohopokeliga the lakes above might be used as reservoirs and connected with the canal by feeders.

It is evident that locks would be required in getting from Lake Winder to the summit level at Alligator Lake, or to Lake Tohopokeliga. To go lower down, and strike Canoe Creek, which flows from Alligator Lake to Little Cypress Lake, would not be complying with the act, which makes Tohopokeliga Lake a point in line, nor could that be done without locks, as Little Cypress is but very little lower than Tohopokeliga. From the Tohopokeliga we can easily pass without locks to the Okeechobee via Lake through the Kissimmee River, and a series of large lakes which really constitute a part of the Kissimmee River. This Kissimmee River is very crooked, and to pass boats drawing even 2 feet during the dry season would require clearing out and dredging.

There is a small boat drawing about 2 feet now on the Kissimmee River which goes from the Tohopokeliga Lake to the Okeechobee Lake. The act requires us to go to Charlotte Harbor, or Peace Creek, and while we could go through the Okeechobee via the Caloosahatchie River to Charlotte Harbor we could not utilize Peace Creek, as seems to be the intention of the act.

It was necessary, therefore, to look for a line to Peace Creek, and to that end Mr. Gartland was required to leave the Kissimmee at the mouth of Tiger Creek, and continue his line, as before mentioned, to the mouth of Bowlegs Creek, 2½ miles below Fort Meade on Peace Creek; and Mr. Le Baron was required to explore the country south of Mr. Gartland's lines in order to discover whether the chain of lakes existing there, taken in connection with the Big Charleypopka, might not prove better ground and afford more water. I will therefore continue the description of Mr. Gartland's line, and then Mr. Le Baron's line from the point it diverges to strike Big Charleypopka.

So far, we have followed the line from Lake Winder to a point where the Kissimmee River leaves Lake Tohopokeliga. By the first and most northern line, as the survey went, the distance would be 52.98 miles, which could be reduced to 48.31 miles.

By the second line, directly from Alligator Lake to the same point, we have a distance of 38.7 miles. We now follow the Kissimmee River 5.83 miles to Little Cypress Lake, and find the river very crooked, at points narrow and shallow, while at others it is deep. It will average between 5 and 6 feet in depth. Across Little Cypress is about 3 miles, and the depth varies from 4 to 8 feet, as far as I could sound it.

The weather was so stormy when I crossed it that it was impossible to get soundings on the center of the lake. My guide informed me there was from 15 to 20 feet water in the center; and I expect there was.

From Little Cypress to Big Cypress, or Hatchinneeha, is about 5 miles, and the river is a much better stream than it is above, varying in depth from 4.5 to 10 feet. Across Hatchinneeha is about 3.5 miles. We crossed this lake in a storm, and were driven ashore a mile from the point we wanted to make, and could not take soundings. It is a very large lake, and I should think varied from 3 to 15 feet in depth.

From Hatchinneeha to the Kissimmee Lake is about 5 miles, and the soundings varied from 7 to 12 feet. This part of the river is very crooked, and would require straightening. Across the Kissimmee Lake to the mouth of Tiger Creek is 2.66 miles. This lake varies in depth from a few inches close to shore to 19 feet in the channel. I sounded it from one end to the other on the 29th of April, 1881. It is at least 15 miles long. We have fallen from Tohopokeliga Lake to the mouth of Tiger Creek, in the Kissimmee Lake, 5.9 feet, and are 39.9 feet above Lake Winder. Passing on via Tiger Creek to Tiger Lake 1.99 miles, we rise 0.72 feet; thence across Tiger Lake 2.25 miles, to Walk-in-the-Water 3.26 miles, we rise 8.55 feet above Tiger Lake. Crossing Walk-in-the-Water 3.6 miles, we continue by Tiger Creek and its western prong to Lake Lenore 6.55 miles, and rise 24.16 feet above Walk-in-the-Water.

Crossing Lake Lenore 1.1 miles, and reaching Little Tiger Lake in the distance of 0.42 miles, we rise 7.55 feet; thence 1 mile across Little Tiger and over sand hills sixty-odd feet above Little Tiger for 1.95 miles, we reach Crooked Lake, 32.42 feet above Little Tiger and 113.34 above Lake Winder. We leave Crooked Lake after traversing it 1.6 miles, and pass across comparatively high ground for 2.85 miles to Lake Buffum, 6.18 feet above Crooked Lake, 119.52 feet above Lake Winder, and 138.265 feet above high-tide at Charlotte Harbor. Lake Buffum is the summit lake on this line, which continues across the Lake 1.6 miles, and via Bowlegs Creek to Peace Creek, 15.05 miles, and falls below Lake Buffum 65.125 feet. At this point Peace Creek is 54.4 feet above Lake Winder, and 73.14 feet above high-tide at Charlotte Harbor.

It is very evident that locks would be required over the last portion of the line described from Lake Kissimmee to Peace Creek, as well as over the first portion from Winder to Tohopokeliga Lake. A simple reconnaissance of Peace Creek is sufficient to show that both locks and dams would be necessary to make Peace Greek navigable to Charlotte Harbor all the year round. In addition to locks and dams, it would require a great deal of work to straighten Peace Creek so that boats could navigate it, even if there was a sufficiency of water.

Peace Creek falls from the mouth of Bowlegs Creek to the mouth of the Big Charleypopka 56.42 feet according to Mr. Le Baron's levels, a distance of 43.82 miles, an average fall of 1.28 feet per mile. From the mouth of Big Charleypopka to Live Oak Point it falls 16.72 feet, a distance of 51.54 miles or an average of 0.32 feet per mile.

I think it is very clear that locks would be required on this route from Lake Winder to Live Oak Point. Let us now go back on Mr. Gartland's line to Crooked Lake and see what sort of a line we can get by following Mr. Le Baron's survey. First, we cross Crooked Lake, traversing it only 1 mile, and then passing over a sandy ridge 0.94 miles, we descend from the level of Crooked Lake (132.083) to the level of Lockapopka (116.63) 15.45 feet. From Lockapopka to Lake Livingstone, a distance of 4.09 miles, we fall 25.1 feet. From Lake Livingstone to the divide between it and the head-waters of Big Charleypopka (Old Town Swamp, the middle prong) we rise 42.48 feet in 2.74 miles, attaining an elevation only 4.25 feet lower than Lake Buffum, and without the supply of water at this summit which Lake Buffum at the other summit would afford.

From the divide to Peace Creek at the mouth of Big Charley, we fall 117.29 feet, following the Old Town Swamp and the Big Charley all the way, and finding in the dry season little or no water the greater part of the distance. After reaching Peace Creek at the mouth of the Big Charleypopka, we continue, as before described, down Peace Creek to its mouth at Live Oak Point, in Charlotte Harbor, falling only 16.72 feet. Mr. Le Baron says of the Big Charleypopka, that he ran his line down the creek, first on one side and then on the other, until he reached High Ford, when he followed the west bank, taking levels, whenever the line crossed, of the swamp and sections of the water. English Ford, he says, was dry, and only 2 or 3 inches of water at High Ford.

Between English Ford and the mouth of North Prong the channel was dry in many places, with occasional pools of deep water. "The combined waters of Old Town Swamp and the North Prong only made a small rivulet of about 5 feet in width, by 2 or 3 inches in depth." "At times of excessive flood the whole country for many miles on each side has been overflowed." The South Prong, Mr. Le Baron says, "is evidently of greater volume than the main creek, for after the accession of its waters the creek becomes and continues of respectable size, with a steady current." At Whidden's Ford, Mr. Le Baron says, the water was only 0.6 foot deep May 8, 1881, but that he saw evidence of its having been from 19 to 20 feet above that level. All this only goes to show that it might be possible, at great expense for storage reservoirs, to build a small canal with many locks, and that a steamboat route without locks is impracticable.

I passed through Charlotte Harbor, from Live Oak Point to Punta Rassa, several times, made notes and observations which satisfied me that the United States Coast and Geodetic Survey chart would enable an engineer to decide upon the best entrance to Charlotte Harbor for a canal, and would also enable him to make a pretty close estimate of the amount of dredging that would be required. I also examined the Saint John's River, from Sanford to Lake Winder, and found it extremely crooked, and in some few places quite shoal; I consider it, however, capable of being made navigable for boats drawing from 4 to 5 feet of water, and perhaps more.

The levels taken by Mr. Gartland of Lockapopka and Reedy Lake, show that Reedy Lake is 32.25 feet below Lockapopka, and only 16.44 feet above Walk-in-the-water Lake. This would suggest the propriety of leaving Mr. Gartland's line at Walk-in-the-water, and approaching Peace Creek via Reedy Lake. We find, however, sand hills intercepting us on this route, and after we get to Reedy Lake we have a greater ascent to the divide between Lake Livingstone and the Big Charley than we have from Lockapopka.

The only southern outlet the Walk-in-the-water Lake has is a swamp called "Blue Jordan," which connects it with Istokpoga at high-water, and thence flows to the Kissimmee.

The impracticability of a through cut from Saint John's River to Charlotte Harbor, on Peace Creek, via Tohopokeliga Lake is, I think, demonstrated.

The information obtained by the surveys will be of great service in indicating lines of improvements. While the enormous expense a through cut would necessitate is shown, the practicability of building cheap canals for small boats is clearly proven. It has suggested to my mind the improvement of the Kissimmee River, which seems so feasible that it will not be long before private capital will embark in it.

The railroad, which is being extended from Orlando to Tohopokeliga Lake, will connect the Saint John's and the Kissimmee. All that will be required for a few years is two or three light-draught boats to run from Tohopokeliga to Okeechobee. The number of these boats may be increased as commerce demands, and by building two or three locks on the Caloosahatchie communication is secured with Punta Rassa, Charlotte Harbor, and the Gulf of Mexico at comparatively small cost.

But that is not all the information suggests, for in demonstrating the fact that a route without locks is impracticable, it indicates where to look for the route with fewest locks.

By referring to the map you will observe that the Saint John's has its source within 48 miles of Lake Okeechobee; that the heads of creeks which flow into the Saint John's and Okeechobee are much closer together. Mr. Le Baron says, "Of this distance (48 miles) 36 miles, or the whole of six townships, is through morasses so boggy and low that the United States land surveyors were unable to penetrate them to subdivide them, and they reported them as impassable."

All the maps agree in representing that country as low, flat, and interspersed with lakes, ponds, lagoons, and saw-grass prairies. The Saint John's flows nearly due north, while the Kissimmee flows nearly due south. In short, the planes of the two streams must intersect, if prolonged south. And the question to be decided is not where they do intersect, but where they come nearest to each other.

This idea was suggested to me by Colonel Allen, a graduate of West Point, living in Florida, and struck me at the time as well worth bearing in mind.

The better I become acquainted with the topographical features of the country, the more satisfied I was that the suggestion was good, and, if kept in mind, might lead to valuable information.

For the purpose of finding where the planes of these two streams approached each other nearest, I was very anxious to connect the Saint John's with the Okeechobee by a line of levels. The want of means forbade my carrying out this project. But the levels I have, if correct, will approximate the truth, when combined with those of Mr. Meigs's survey of 1880. Mr. Meigs makes Lake Okeechobee (or Hickpochee, which he thinks is the same level) 21.94 feet above mean low-tide at Myers, Fla. Mean high-tide, the base Mr. Le Baron has reduced his level to, is about 1.7 feet above mean low-tide; therefore Lake Okeechobee, when reduced to our base, is 20.24 feet above mean high-tide in Charlotte Harbor, supposing tides at Live Oak Point and Myers are the same level. Now, Lake Winder is only 18.74 feet above this same base; therefore Lake Okeechobee is only 1.5 feet above Lake Winder. In an air line Lake Okeechobee is by the maps 72 miles south of Lake Winder, so that the headwaters of the Saint John's, Lake Washington, and the saw-grass ponds south of it must be nearly the same level, if not higher than Okeechobee. If these levels are correct, there would be no difficulty in connecting the Saint John's River with the Okeechobee by a clear cut. In fact, a clear cut might be made with a much greater difference of level.

The only locks, then, which would be required would be from Okeechobee to Myers, via the Caloosahatchie, and we would require two or three locks to overcome the 21.94 feet ascent in the Caloosahatchie. It is possible, though I do not think it probable, that one lock might suffice to overcome this difference of level. Information gathered from citizens familiar with the country, and my own observations east of the Kissimmee, coupled with Mr. Le Baron's report, and observations on other surveys in that vicinity, lead me to believe the last route suggested, from the head of the Saint John's, via either Taylor's or Cow Creek, to the Okeechobee, is the most practicable and cheapest route that can be had. I am inclinded to think the line should go to the east of Fort Drum and down Cow Creek, to the Okeechobee. I am told the waters of the Saint John's and the Okeechobee at high-water during the rainy season are separated for only a short distance, and by a very low ridge. This ridge is an extension of the divide between the Kissimmee and the Saint John's. By referring to the military map of Florida you will find that east of Forts Drum, Lloyd, and Van Swearingen the land is low and swampy, with numerous small streams running in almost every direction. You will also notice that near Fort Van Swearingen and the head of Cow Creek the ridge is very narrow and not well defined. This corresponds with the statements of citizens familiar with that country. There seems to be very good reason to suppose that our levels are not very far out, although it cannot be expected that a single line of levels without test lines would be exactly correct.

While I am not expected to report on a ship-canal, I hope an idea which suggests itself in that connection will not be out of place in this report. It is that a ship-canal might be cut from Saint Lucie, or some point near it, through Okeechobee, via Caloosahatchie, to Charlotte Harbor and the Gulf, more easily than between any other points on the Atlantic and Gulf coasts of the State of Florida.

The distances would be as follows: From Saint Lucie to the mouth of Cow Creek, by canal 33 miles; thence across Okeechobee 38 miles, and down the Caloosahatchie 63.78 miles to its mouth. This canal might be built with locks, but if it were made a clear cut it would not have a cut on it equal to some of the cuts of the Suez Canal. Of course it would be expensive, and I merely mention these ideas as they suggest themselves in connection with my surveys.

In regard to the commercial advantages of this steamboat route, it is very hard to form an idea of the freight which would seek it. If it was a ship-canal the advantages might be more readily compared with the cost. But it is to be a steamboat route, and the inference from the words of the act is that boats drawing only 3 or 4 feet are to be provided for.

Your report on the canal from Saint Mary's to the Gulf of Mexico shows clearly enough the advantages of a ship-canal. But in this instance the vessels which would use the route would depend largely on local freights, as they could not go to sea. This route, however, would open up a portion of South Florida which at present has no transportation facilities, and which is very productive, or capable of being made so.

Lands now lying idle and unoccupied would be made accessible and thrown on the market and be readily sold. Some of these lands thus made available would produce not only the semi-tropical fruits and all kinds of vegetables, but also as fine sugar as any lands in the United States, as the cane is never injured by frost, and will grow for two or three years without being replanted. Sugar lands contiguous to the canal might be improved by drainage.

The principal articles which would furnish freight for the canal are as follows:

Fruits.—Bananas, pineapples, oranges, lemons, limes, guavas, strawberries, figs, grapes, and melons.

Market vegetables.—Cucumbers, tomatoes, sweet potatoes, cabbages, turnips, beets, pease, and others too numerous to mention, as I believe any sort of vegetable will grow in Florida.

Beef cattle, live stock, and lumber.

General merchandise.—A large proportion of the above-mentioned articles would be sent out of the State, while articles of general merchandise would be returned.

The cultivation of fruits and vegetables for market is increasing rapidly.

I believe Southern Florida is much better adapted to the growing of semi-tropical fruits than Middle or Northern Florida. I saw growing at Fort Myers cocoanuts, dates, limes, lemons, oranges, alligator or avocado pears, mammee sapota, sapotilla, guavas, pineapples, and other fruits which I cannot now recall, yet they are not shipped because the only outlet to the market is south, and to ship fruit south would be like sending coals to Newcastle. The consequence is, little or no attention is given to these products in this part of the State, where they grow best. The people are mostly engaged in raising cattle for the Cuban market.

I append table of distances and levels, showing the distances from Lake Winder, by the line surveyed, to Peace Creek and Charlotte Harbor, and also the distances, as measured on the map, from Lake Winder, via the proposed line to Okeechobee and down the Caloosahatchie to its mouth.

The northern end of this route is in the collection district of Jacksonville, Fla.; the southern terminus is in the collection district of Key West, Fla.

I append:

1st. Statement of Mr. F. N. Wicker, collector at the port of Key West, of the revenue collected at that port from customs, tonnage, and hospital dues from July 1, 1879, to June 30, 1880; also a statement of the number and value of cattle and hogs exported from the same port.

2d. Statements of Mr. Edwin Higgins, deputy collector of the port of Jacksonville, Fla.: No. 1. Showing tonnage of vessels doing business on the Saint John's River June 30, 1881, which do not enter or clear from Jacksonville; United States vessels entered and cleared, coastwise and for foreign ports. No. 2. Showing foreign vessels cleared, and for foreign ports, also value of exports and imports, and the amount of duties collected.

I also append tables Nos. 1, 2, 3, 4, 5, 6, and 7, giving distances and elevations on the different lines, and the rainfall at Punta Rassa.

Two maps made by Mr. John Gartland, showing the routes he surveyed, accompany this report, and I have marked on the tracing in red ink the route surveyed, and the one I suggested as the most feasible route.

I wish here to express my thanks to Mr. John Gartland and Mr. J. Fras. Le Baron for the manner in which they conducted their surveys, and also to merchants and citizens of Orlando, Fort Meade, Fort Ogden, and Fort Myers, for valuable assistance.

I am, very respectfully, your obedient servant,

W. G. WILLIAMSON,
Assistant Engineer.

Brevet Maj. Gen. Q. A. GILLMORE,
Lieutenant-Colonel, Corps of Engineers, U. S. A.

N. B.—I have retained the spelling of the names of lakes as they are given on the military maps and maps furnished from Washington, because I suppose the Army officers who made these maps were better prepared to give the correct spelling than any one now could be, as they evidently tried to spell them as the Indians then called them, whereas now we find them spelled in many different ways on modern maps, every surveyor adopting his own idea of the proper way of spelling. *Peace Creek* is, I think, correctly spelled, and should not be spelled Pease Creek (*vide* Le Baron).

W. G. W.

Statement of the revenue collected at the port of Key West, Fla., from customs, tonnage, and hospital dues, from July 1, 1879, to June 30, 1880.

Months.	Duties.	Hospital dues.	Tonnage.	Total.
1879.				
July 31	$10,025 41	$342 70	$266 70	$10,634 81
August 31	8,786 37	248 21	106 05	9,140 63
September 30	6,333 11	287 01	204 60	6,824 72
October 31	12,210 45	231 10	36 19	12,477 74
November 30	23,932 60	183 52	941 27	25,057 39
December 31	23,705 70	139 49	193 82	24,039 01
1880.				
January 31	22,685 26	197 89	193 82	22,882 65
February 29	19,050 96	159 82	1,116 96	20,327 74
March 31	19,924 68	348 34	332 53	20,605 55
April 30	17,717 58	454 54	184 43	18,356 50
May 31	11,493 99	248 51	477 01	12,219 51
June 30	7,676 43	372 41	167 94	8,216 78
	183,542 49	3,213 04	4,027 50	190,783 03

NUMBER AND VALUE OF CATTLE EXPORTED FROM THE PORT OF KEY WEST DURING THE FISCAL YEAR ENDING JUNE 30, 1880.

Number of cattle, 29,548; value	$406,915
Number of hogs, 152; value	1,186
Total	408,101

F. N. WICKER,
Collector.

CUSTOM-HOUSE, *Key West, Fla., June* 24, 1881.

LETTER OF COLLECTOR OF CUSTOMS AT JACKSONVILLE, FLORIDA.

CUSTOM-HOUSE, COLLECTOR'S OFFICE,
Jacksonville, Fla., June 21, 1881.

SIR: I forward statistics as requested by you; hope the information may be of service.

Respectfully, &c.,

EDWIN HIGGINS,
Deputy Collector.

W. G. WILLIAMSON, Esq.,
United States Assistant Engineer.

TONNAGE OF VESSELS DOING BUSINESS ON THE SAINT JOHN'S RIVER JUNE 30, 1881, WHICH DO NOT ENTER OR CLEAR FROM JACKSONVILLE.

	Number.	Tonnage.
Sail vessels	6	124.85
Steam vessels	33	2,922.29
Total	39	3,047.14

Year ending June 30, 1881: United States vessels entered coastwise, 384; tonnage, 168,659; men, 4,618. United States vessels entered from foreign ports, 21; tonnage, 3,754; men, 140. Foreign vessels entered from foreign ports, 9; tonnage, 743; men, 58. United States vessels cleared coastwise, 384; tonnage, 169,740; men, 4,599. United States vessels cleared for foreign ports, 31; tonnage, 6,252; men, 223.

TABLE NO. 1.—*Table of distances and elevation of points along the line surveyed from Lake Winder to the Kissimmee River where it leaves Lake Tohopokeliga.*

Names of places.	Distances between stations.	Total distances from Winder.	Elevations above high-tide at Charlotte Harbor.
	Miles.	*Miles.*	*Feet.*
Lake Winder	0.00	0.00	18.737
Head of Wolf Creek	10.11	10.11	61.989
Alligator Lake, east side	16.94	27.05	71.484
Alligator Lake, west side	1.35	28.40	71.484
Isabel Lake, south end	2.01	30.41	71.804
Isabel Lake, north end	1.00	31.41	71.804
Little Tohopokeliga Lake, southeast corner	1.11	32.52	70.812
Little Tohopokeliga Lake, southwest corner	4.80	37.32	70.812
Tohopokeliga Lake, northeast corner	4.36	41.68	64.593
Tohopokeliga Lake, south end	11.30	52.98	64.593

The above distance, 52.98 miles, by following Cross Prairies Creek and straightening the lines at other points, may be reduced to 48.31 miles.

TABLE NO. 2.—*Table of distances and elevations along the line surveyed from Lake Winder, via Alligator Lake, thence directly west to Tohopokeliga Lake.*

Names of places.	Distances between stations.	Total distances from Winder.	Elevations above high-tide at Charlotte Harbor.
	Miles.	*Miles.*	*Feet.*
Lake Winder	0.00	0.00	18.737
Head of Wolf Creek	10.11	10.11	61.989
Alligator Lake, east side	16.94	27.05	71.484
Alligator Lake, south end	3.40	30.45	71.484
Tohopokeliga Lake, southeast corner	4.85	35.30	64.593
Tohopokeliga Lake, exit of Kissimmee	3.40	38.70	64.593

TABLE NO. 3.—*Table of distances from exit of Kissimmee River from Tohopokeliga Lake to the mouth of Bowlegs Creek or Peace Creek.*

Names of places.	Distances between stations.	Total distance from Tohopokeliga.	Elevations above high-tide at Charlotte Harbor.
	Miles.	*Miles.*	*Feet.*
Tohopokeliga Lake, exit of Kissimmee	0.00	0.00	64.593
Cypress Lake	5.83	5.83	....
Across Cypress Lake	3.00	8.83	....
Lake Cypress or Hatchinneeha	5.00	13.83	60.235
Across Cypress or Hatchinneeha	3.50	17.33	60.235
Lake Kissimmee	5.00	22.33	59.063
Lake Kissimmee, mouth of Tiger Creek	2.66	24.99	58.068
Tiger Lake	1.99	26.98	59.384
Across Tiger Lake	2.25	29.23	59.384
Walk-in-the-water Lake	3.26	32.49	67.942
Across Walk-in-the-water Lake	3.60	36.09	67.942

TABLE No. 3.—*Table of distances from exit of Kissimmee River, &c.*—Continued.

Names of places.	Distances between stations.	Total distance from Tohopokeliga.	Elevations above high-tide at Charlotte Harbor.
	Miles.	*Miles.*	*Feet.*
Lake Lenore	6.55	42.64	92.104
Across Lake Lenore	1.10	43.74	92.104
Little Tiger Lake	0.42	44.16	99.655
Across Little Tiger Lake	1.00	45.16	99.655
Crooked Lake	1.95	47.11	132.083
Across Crooked Lake	1.60	48.71	132.083
Lake Buffum	2.85	51.56	138.265
Across Lake Buffum	1.60	53.16	138.265
Mouth of Bowlegs Creek	15.05	68.21	73.140
Live Oak Point, mouth of Peace Creek	95.36	163.57	00.000

TABLE No. 4.—*Table of distances of proposed line from head of Saint John's River to mouth of Caloosahatchie, via Cow Creek and Lake Okeechobee.*

Names of places.	Distances between stations.	Total distance from Winder.	Elevations above high-tide at Charlotte Harbor.
	Miles.	*Miles.*	*Feet.*
Lake Winder	0.00	0.00	18.737
Mouth of Cow Creek	80.00	80.00	20.240
Across Okeechobee Lake	38.00	118.00	20.240
Hikpochee Lake	2.50	120.50	20.240
Across Hikpochee Lake	3.00	123.50	20.240
Sugarberry Hammock	3.50	127.00	....
Fort Thompson	3.50	130.50	....
Mouth of Caloosahatchie	51.28	181.78	00.000

The distances in the above table are estimated from the map, and taken from Mr. Meigs's report of the survey of the Caloosahatchie.

TABLE No. 5.—*Table of distances from Crooked Lake, via Mr. Le Baron's line, to Live Oak Point, Charlotte Harbor.*

Names of places.	Distances between stations.	Total distance from Crooked Lake.	Elevations above high-tide at Charlotte Harbor.
	Miles.	*Miles.*	*Feet.*
Crooked Lake	0.00	0.00	132.083
Across Crooked Lake	1.00	1.00	132.083
Lochapopka	0.94	1.94	116.630
Across Lochapopka	0.50	2.44	116.630
Lake Livingstone	4.09	6.53	91.530
Across Lake Livingstone	2.25	8.78	91.530
Divide between Lake Livingstone and Old Town Swamp	2.74	11.52	134.010
Buckhorn Prong	15.45	26.97	55.930
Peace Creek, mouth of Big Charleypopka	17.93	44.90	16.720
Live Oak Point, Charlotte Harbor	51.54	96.44	00.000

By Mr. Gartland's surveyed line the distance from Winder to Crooked Lake is 100.09 miles. Adding the above 96.44, we have 196.53 miles by Mr. Le Baron's line; 191.86 miles by the reduced distances, Mr. Gartland's first line; 182.25 miles by the line from Winder to Alligator, thence direct to Tohopokeliga.

TABLE No. 6.—*Table comparing the different lines.*

1. Line from Lake Winder to Charlotte Harbor, via Alligator Lake, Isabel Lake, Little Tohopokeliga, Tohopokeliga, &c., Bowlegs Creek, and Peace Creek, to Charlotte Harbor:

From Winder to exit of Kissimmee from Tohopokeliga	52.98
From Tohopokeliga to mouth of Bowlegs Creek	68.21
From Bowlegs Creek to Live Oak Point	95.36
	216.55

2. By the same route, reducing the distance surveyed by straightening the lines 48.31+163.57= ... 211.88

3. By the second line from Winder to Alligator Lake, thence directly to the south end of Tohopokeliga:

The exit of Kissimmee	38.70
Tohopokeliga to mouth of Bowlegs Creek	68.21
Mouth of Bowlegs Creek to Live Oak Point	95.36
	202.27

4. By Gartland's line to Crooked Lake, and then by Le Baron's line to mouth of Big Charleypopka ... 196.53

By same reduced	191.86
By line from Winder to Alligator, and then direct to Tohopokeliga	182.25
By proposed line, Table No. 4	181.78
The line suggested as a ship-canal route would be 134.78 miles long from Saint Lucie to mouth of Caloosahatchie	134.78

TABLE No. 7.—*Table showing amount of rainfall at Punta Rassa for the years* 1873 *to* 1880, *inclusive, and for each month of the year* 1881, *in inches and decimals of an inch, furnished by United States Signal Service, Mr. Evans, observer.*

1873	59.2
1874	38.16
1875	29.71
1876	44.34
1877	38.99
1878	51.81
1879	46.29
1880	39.53

Months.	1880.	1881.
	Inches.	*Inches.*
January	3.22	4.02
February	1.26	0.52
March	0.08	1.18
April	0.55	0.54
May	5.32	3.13
June	2.45	2.53
July	3.76	3.60
August	8.55	....
September	2.50	....
October	8.10	....
November	1.81	....
December	1.98	....

J 15.

SURVEY OF THE NORTH END OF INDIAN RIVER WITH A VIEW TO ITS CONNECTION, BY THE HAULOVER, WITH MOSQUITO LAGOON.

UNITED STATES ENGINEER OFFICE,
New York, December 3, 1881.

GENERAL: I have the honor to submit herewith a report of a survey made at the north end of Indian River, Florida, with an estimate of the cost of opening a suitable channel between it and Mosquito Lagoon, about one-half a mile to the eastward, as provided for by section 3 of the river and harbor act approved March 3, 1881, assigned to my charge by department letter dated March 21, 1881.

The survey was made during the month of August, 1881, by Mr. J. F. Le Baron, assistant engineer.

The place referred to is located in Volusia County, and is known as the Haulover. A canal was dug here in the years 1853 and 1854, to connect Indian River and Mosquito Lagoon, both estuaries of the Atlantic Ocean, running more or less parallel to the east coast of Florida, with a comparatively narrow strip of land between them and the ocean.

From the Haulover, Indian River runs in a south-southeast direction for about 100 miles, and then connects with the sea by Indian River Inlet, but actually continues farther south about 40 miles, under the names of Saint Lucie Sound and Jupiter Narrows, respectively, and terminates in a pass to the ocean named Jupiter Inlet.

The general direction of Mosquito Lagoon is about north-northwest. Its southern end is about 18 miles southeast of the head of Indian River and about 14 miles northeast of Cape Canaveral. It connects with the ocean at Port Orange by Mosquito Inlet, about 32 miles north of the Haulover, but extends farther north, under the name of Halifax River.

Indian River and Mosquito Lagoon are separated by a low and nearly level isthmus, which is about 3 miles wide at its northerly end, at the head of Indian River, but gradually narrows as it extends in a southeasterly direction, finally merging in the marshes north of Merritt's Island. At the site of the Haulover, 8 miles from the head of Indian River, the isthmus is less than one-half mile in width.

The scheme of opening a passage from Mosquito Lagoon to Indian River was referred to over fifty years ago, in an act of Congress approved March 2, 1827, which provided that if any part of certain appropriations should remain unexpended it should be applied to that work, as being in the line of communication to Cape Florida.

Nothing further was done on the part of government until, by act approved June 15, 1844, the sum of $1,500 was appropriated for improving the Haulover.

A survey of the locality was made in 1845 by Lieut. J. E. Blake, United States Topographical Engineers, supposed to have been done by direction of General Worth, with a view of opening a passage for boats carrying supplies to the United States troops stationed at various points on the coast.

A subsequent appropriation of $5,000, made by act approved August 30, 1852, was applied during the years 1853 and 1854 to the construction of a canal, on the plan and under the direction of Lieut. (now Brig. Gen. and Chief of Engineers) H. G. Wright.

The cut was limited to a bottom width of 8 feet and a depth of water of 2 feet, with vertical banks where coquina rock occurred, and with side slopes of 45 degrees in sand. These dimensions were deemed about sufficient for the class of boats then in use on either lagoon; in fact, it was thought that not more than 2 feet could be carried up Mosquito Lagoon to the Haulover. The estimate provided for continuing the channel 300 feet into each lagoon beyond the shore line.

The necessity of making further appropriations to secure a proper and permanent channel was pointed out at that time by Lieutenant Wright in his official communications, but nothing further was done by the United States Government until near the close of the last session of Congress, when the survey just completed was directed to be made.

The isthmus is nowhere more than about 8 or 9 feet above the water surface. The top soil is generally sand, with underlying coquina rock—a conglomerate of small broken shells held together by some natural cement. It crops out at many points, and the indications are that over considerable areas this rocky substratum is continuous. The upper layer is the finest and hardest; lower down its cementing power deteriorates.

The surface of the bed of Indian River and Mosquito Lagoon is composed of sand and finely-broken shells. In Haulover Bay, a small estuary of Indian River, immediately in front of the western entrance of the canal, mud is found.

Coquina rock, with shell, also underlies the bed of Indian River, Haulover Bay, and the salt marsh separating them. In Mosquito Lagoon it was found at one place only, in the vicinity of the eastern entrance of the canal; otherwise the substratum consists here of mud and clay.

These facts were elicited by numerous borings made during the recent survey, and accord with the results of investigations made in former years by Lieut. J. E. Blake and Lieut. H. G. Wright.

The fluctuations of the water-level on either side of the Haulover, due to the tidal wave of the ocean, are very small. In Mosquito Lagoon the mean rise and fall of tide is stated to be 1½ inches, and in Indian River 3 inches.

A much greater difference in the height of the water surface is caused by heavy winds and rains. Assistant Le Baron, who has resided for several years in the neighborhood of the Haulover, says a heavy and long-continued rainfall causes the level of Indian River to rise sometimes as much as 4 feet above its mean height. It falls to its ordinary level very gradually, owing to its extended surface and the long distance between the seaward entrance and the head. Mosquito Inlet being much nearer, the water surface of Mosquito Lagoon is lowered more rapidly, thus producing a difference of level at the Haulover and a current through the canal.

Strong winds produce similar effects. They cause a difference of level between the water surfaces at the two ends of the Haulover, amounting sometimes to as much as 2 feet.

At one time during the recent survey a heavy northeast storm raised the water of Mosquito Lagoon 20 inches above the level of Indian River, creating a current through the Haulover Canal of 2.8 miles per hour. The prevailing winds are from the north.

The field operations consisted chiefly in running a transit and level line from Mosquito Lagoon to Indian River, with cross-sections every 100 feet. Tide gauges were set up in Haulover Bay and Mosquito Lagoon. Soundings were carried out on either side to about 6 feet water. Nearly forty borings were made, partly in the existing canal, and partly along its axis produced into Haulover Bay, Indian River, and Mosquito Lagoon. The soundings and borings, as given on the accompanying chart, are referred to the mean low-water datum of the Coast and Geodetic Survey, as shown on a stone bench-mark in Haulover Bay.

An examination of the isthmus north and south of the present Haulover Canal seemed to indicate that about 1 mile north of it a rather more eligible site might be had if a new canal were to be made, as no bay and salt marsh would there be interposed between the western end of the land cut and Indian River, reducing the distances between the 5-foot curves on either side about half a mile. The advantages offered by the existing cut in facilitating the operations of a dredge-boat are, however, too manifest to render the abandonment of the old line expedient or desirable.

The canal had originally a width of 12 feet at the water-surface in the earth cut. It varies now from 12 to 33 feet, and the depths from 1.7 to 3.8 feet. The banks are undermined by the action of the current on the loose shell below the rock. The material detached from the caving sides is carried out and deposited in the form of shoals near the entrances.

The canal is generally in a neglected condition, although some years ago it was cleared out by private enterprise for the passage of boats of 11 feet beam, and from 16 to 18 inches draught.

The length of the land cut is now 2,087 feet; originally it was 2,150 feet. Assistant Le Baron found no traces of the channel on either side, included in Lieutenant Wright's estimate of 1853. A low line of riprap, extending into the lagoon on the north side of the channel, is nearly covered up by sand. It seems to have failed its purpose, if it was designed to maintain the depth of the eastern entrance channel.

Comparing the Coast and Geodetic Survey chart of 1875–'76 with the results obtained by the recent survey, it appears that in the vicinity of the Haulover the 4 and 5 foot curves are now on each side about one-fourth mile nearer to the shore. A gradual receding or wearing away of the shore lines seems to have taken place since Lieutenant Blake made his survey in 1845.

UNITED STATES RESERVATION.

By a proclamation of the President of the United States, dated August 26, 1880, a reservation was declared, embracing a tract of land 1,000 feet wide north and south of the center line of the canal. In the same year the United States Land Office had a survey made of the land thus reserved except a portion belonging to Andrew Jackson lying within the southern part of the reservation.

The tract then surveyed includes land entered by certain settlers under the homestead law prior to the President's proclamation. Most probably the parties that have settled lawfully within the reservation will enter claims for damages if compelled to cede their land to the United States.

PLAN OF IMPROVEMENT.

The plan proposed by Assistant Engineer Le Baron essentially consists in enlarging the cross-section of the present canal and in continuing the cut to deep water on each side between parallel training-walls or jetties.

The bottom width of the improved canal is designed to be 60 feet, depth of water 4½ feet, side slopes in loose material 1 on 2, and in rock cut 1 on ¼. To prevent caving in and washing off of the banks, the slopes of the land cut would be revetted with coquina riprap to a height of 4 feet above mean low-water. This protection is intended to remove one of the principal causes of shoaling at both entrances.

Cuts of cross-sections similar to those of the land cut would be made by dredging in continuation of the line of the latter. The length of the cut in Mosquito Lagoon would be 1,880 feet in Haulover Bay, and Indian River 5,020 feet, 1,170 feet of the latter being through coquina rock, averaging 4 inches thick.

The jetties on either side are to be about 100 feet apart. In Mosquito Lagoon their length would be 2,120 feet, if carried out to a 5.8 depth of water, their width at the root being 6 feet, and at the head 14 feet.

In Indian River their length is estimated at 4,050 feet, ending in 4.8 feet of water, the width on shore being 6 feet, and at the head 12 feet.

The project also provides for a cross-dam, 610 feet long and 8 feet wide, across Haulover Bay, near the southern border of the channel across that estuary.

The jetties and the cross-dams are considered to be necessary for preserving the depths of the channel secured by dredging.

These structures are designed to consist of mattresses, made in the form of palmetto-log rafts covered with compact layers of brush, the aggregate thickness of the work being 30 inches. These mattresses will be overlaid and held in place by coquina rock obtained from the excavations.

The top of the jetties will be about 1 foot below mean low-water; the cross-dam will reach about 6 inches above that level.

Abundant material for making the mats is found within available distances, and in that locality it is believed that coquina rock will answer as a substitute for harder and more compact varieties of stone.

Such rock gained from the excavations as may not be needed for revetting the slopes or covering the mats will be added to the jetties by dumping it in their rear. As far as practicable the harder kind will be used on the slopes and mats.

It is estimated that in executing the project 70,026 cubic yards of sand and loose shell and 14,972 cubic yards of coquina will have to be removed, and that 1,665 cubic yards of coquina, or about one-ninth of the whole, will have to be dredged from Indian River. The cost of removing sand and shell is estimated at 20 cents per cubic yard, of rock on land at $1.50 per cubic yard, and of rock by dredging at $2 per cubic yard. The mattress work is estimated to cost $1 per square yard.

The total estimated cost of the improvement, as here described in general terms, and including 10 per cent. for contingencies, is about $56,000.

The cost of the land damages that will accrue when the government takes formal possession of the reservation is estimated by Mr. Le Baron at $10,000, making a total of $66,000.

The dimensions of the canal as given in the project for its improvement were adopted with a view of accommodating steamboats of 25 or 30 feet beam, and 3 or 4 feet draught.

It is believed from information received that boats of this class will be put on, as soon as the passage is opened, to ply between points on Indian River, Mosquito Lagoon, and Halifax River, to form a connection at Mosquito Inlet with an outside line of steamers to Jacksonville and Savannah.

The need of an improved canal is deeply felt by the people living on the estuaries named in this report, from Daytona, on Halifax River, to Lake Worth, south of Jupiter Inlet, a distance of over 200 miles. At various times of late they have attempted to combine for the purpose of effecting the improvement, but failed for want of means. The settlers have greatly increased in numbers during the last ten years. They are chiefly engaged in raising tropical and semi-tropical fruits and vegetables. Generally they are compelled to employ all their available capital in rendering their lands productive, and have little to spare in establishing routes of communication. Such lines, however, are of the highest importance to them, and to the further development of the resources of this section of the country. Much interesting information on this point is furnished in Assistant Le Baron's report, to which attention is respectfully invited.

This work is located in the collection district of Saint Augustine, Fla. Saint Augustine is the only port of entry of the district. A statement of the collector of customs is appended to Mr. Le Baron's report.

The following papers are herewith transmitted:

The report of Mr. J. F. Le Baron, assistant engineer, accompanied by
A tracing of plan of the proposed widening of Haulover Canal, and by
A tracing of comparative chart of the vicinity of the Haulover Canal.

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Lieut. Colonel of Engineers,
Bvt. Maj. Gen., U. S. A.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. J. F. LE BARON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., November 11, 1881.

GENERAL: I have the honor to report that in compliance with your instructions of August 1, 1881, I have made an examination and survey for a further improvement of the Haulover Canal, and approaches in Indian River and Mosquito Lagoon, Florida, as provided for in the act of Congress approved March 3, 1881, and submit herewith my report, together with plans and estimates.

The Haulover Canal is situated on the east coast of Florida, and connects the waters of the Indian River (so called) and Mosquito Lagoon, both of which are essentially large shallow salt-water lagoons, with, at this place, no perceptible tide, except such as is caused by the winds.

The United States Coast Survey state that there is a tide in Mosquito Lagoon at this locality of 1¼ inches, and in Indian River of 3 inches.

During long continued and heavy rains the level of Indian River is sometimes raised over 4 feet above its mean height, and keeps nearly at that height, very gradually falling for several months.

Owing to the greater distance from the sea, the greater area of water surface, and a smaller outlet to the ocean than Mosquito Lagoon, the water in the Indian River falls much slower than in Mosquito Lagoon, and it thus happens that Indian River at such times is several feet higher than the water of the lagoon, and there is consequently a very strong current running through the canal from the river to the lagoon. This occurred in 1878, coming under my own observation, when a height of 2 to 3 feet above the lagoon was maintained for several months, and passage through the canal was almost impossible against the current.

For a relief at such a time, should it ever occur again, it would probably be better to open a cut from the head of Banana River to the ocean, through the beach at "Pepper Haulover," where the distance is only a few rods, and allow the water to escape. This would avoid the necessity for locks in the canal, and would be a grateful relief to the submerged plantations, and the cost would be trifling compared to locks.

The present canal is a narrow cut, varying from 33 to 12 feet in width at the water surface, which pierces the narrow isthmus separating these bodies of water about 8 miles from their respective heads, with a depth of water at present varying from 3.8 to 1.7 feet of mean low-water.

HISTORY.

The present Haulover Canal was built in the spring of 1853 by the United States Government according to the plans and under the immediate direction of Lieut. H. G. Wright (now brigadier-general and brevet major-general and Chief of Engineers, U. S. A.), and was designed for the passage of small boats only.

The first survey of this canal was made by Lieut. J. E. Blake, of the United States Topographical Engineers, in 1845, under the direction of General Worth, with the view of opening a passage for boats carrying supplies for the United States Army, then operating against the Indians at various places on this coast, and the canal was subsequently constructed on the line located by him.

The original dimensions of the canal as planned by Lieutenant (now General) Wright gave a width at the ordinary water level of 12 feet in the earth cuts, a bottom width of 8 feet, a depth of 2 feet, with side slopes of 1 to 1 in earth cuts, and with perpendicular sides in the rock cutting. Its length, as given by Lieutenant (now General) Wright in his report to Gen. J. G. Totten, then Chief Engineer of the United States Engineers, was, in 1853, about 2,150 feet. As determined by Lieutenant Blake in his survey in 1845, it appears to have been 2,187 feet according to his profile. It is now 2,087 feet.

DESCRIPTION OF THE COUNTRY.

The narrow isthmus through which the Haulover Canal passes is a low and almost level wind-swept plain, which extends from the great Turnbull Swamp, at the head of Indian River, to the marshes at the north of Merritt's Island. It is covered with a scanty growth of saw palmetto and grass, with occasionally solitary palms and patches of oak scrub and small hummocks. It is underlaid throughout its whole extent with coquina rock, which often crops out on the surface. That this rocky barrier is continuous is proved by the numerous outcrops just mentioned, and by the excavations for wells and other purposes made in several places by the settlers, which I have examined, and is also shown in the ditch surrounding Old Fort Ann. The elevation of this isthmus is nowhere more than 8 or 9 feet, and the plain appears to be almost level, dipping slightly towards Mosquito Lagoon.

The underlying coquina rock, belonging to the post-tertiary deposits, is simply a conglomeration of small shells, more or less broken or comminuted, and cemented with a variable degree of hardness. The upper layers of this rock are the more finely comminuted and the hardest. Descending, the character of the rock gradually changes, growing coarser and losing its cementing qualities, until at a varying depth of from 4 to 6 feet it loses the character of rock entirely and becomes only a homogeneous assemblage of shells, more or less broken and rotten. The bottom of Indian River and Mosquito Lagoon consists of sand and finely comminuted shell. In Haulover Bay the bottom is muddy. This bay and Indian River, and the salt marsh separating them, is underlaid with coquina rock and hard shell at a depth below the bottom of from 2.3 to 5.6 feet, and gradually dips to the west until at a distance of 4,300 feet from the shore it disappears. In Mosquito Lagoon rock was encountered in only one place in the seven borings taken, and then at a depth of 3.7 feet below the bottom and 500 feet from the west shore of the lagoon. A stratum of marsh mud and clay was found to exist in the Mosquito Lagoon at a depth of 4.8 to 3.7 feet below the bottom, 1,460 feet out from the shore, when it dips suddenly to the east, and at 1,980 feet from the shore, where the last boring was taken, is 6.8 feet below the bottom of the lagoon.

DESCRIPTION OF THE SURVEY.

Immediately upon the receipt of your instructions I organized a party at Titusville for the purpose of making the necessary surveys and soundings. Upon the fact becoming known I was waited upon by several of the principal citizens of Titusville and vicinity, all deeply interested in the proposed improvement, and suggesting the examination of additional routes.

As the locality is practically accessible only by water, I chartered the 3-ton sloop Belle, of Indian River, for our conveyance to the canal, which is situated 9 miles in a northeast direction from Titusville.

Upon my arrival there I at once established a gauge on Futch's wharf, in Haulover Bay of Indian River, just north of the canal, at its present western end, and another in the eastern end of the canal near Mosquito Lagoon. I ran a transit line from Mosquito Lagoon to Indian River, and took levels and cross-sections of the present canal every 100 feet. I then ran a double line of soundings on the axis of the canal in Mosquito Lagoon to a depth of 5.8 feet at mean low-water, as determined by the United States Coast Survey, and a corresponding line across the Haulover Bay and in Indian River.

Borings were taken on these lines at intervals of about 200 feet, and also through the present canal. I also took soundings and borings on the other lines in Haulover Bay, shown on the accompanying plan, to establish the best location of a cross-dam.

I also observed the velocity of the current in the present canal during the prevalence of a heavy northeast storm, at which time the water in Mosquito Lagoon was 20 inches higher than the water of Indian River at the gauge at Futch's wharf, and the velocity observed was 2.8 miles per hour. The prosecution of this survey was seriously retarded by a succession of severe rain storms and squalls, at one time giving grave apprehension of a cyclone such as occurred the previous year on this coast, and which was very destructive in its effects on the Indian River. My party, with one exception besides myself, were forced to take refuge in an adjoining settler's house for several nights, as my tents threatened to blow down at any moment, although pitched in a sheltered position.

During a lull in the storm and while the water was too rough for soundings, I made a personal examination of the isthmus, on both sides, and in the middle, as far north as Whatton's place (shown on accompanying chart of comparative soundings), and as far south as the Dummett orange grove, belonging to the Duke de Castellucia (which is also shown on the chart), for the purpose of deciding upon the advisability of a change of location for the new canal, as suggested by many of the citizens before referred to and ordered in your second letter of instructions.

These examinations disclosed the facts that a better location for the canal exists about a mile to the north, just south of Crook's house, shown on the chart. The width of the isthmus at this place is practically the same, between the high-water lines, and there is no marsh, as exists in front of the western end of the present canal. The distance between the 5-foot curves is half a mile shorter at this point than where the canal is now located, but the profile is essentially the same, and rock underlies the whole isthmus, as is found by the outcrops. If the original location of the canal had been made at this point it would have possessed the slight advantage in the depth of water over its present location, and the general alignment of the inland coast navigation would have been better, but with the present cut existing I do not consider a change of location advisable, as the amount already excavated and the advantages which the present cut affords of presenting a continuous curtain which can be assailed its entire length, and in which dredge-boats and scows can be operated, far outweigh the minor advantages of any other route, even without considering the fact that a reservation has been declared on each side of the present canal.

From data furnished me by the Superintendent of the United States Coast Survey, I was enabled to find the stone bench-mark set by the Coast Survey, and to refer my soundings and borings to this coast survey datum of mean low-water. This bench is a coquina stone 6" by 6" 28." The mark is the center of a wooden plug driven in horizontally about six inches below the top, which plug is 0.6 of a foot above the plane of reference mean low-water. The stone was originally buried in the bank 6 feet from the high-water mark, but it is now several feet in the water, owing to the washing away of the shore. It is situated in a small cove on the east side of Haulover Bay, about half-way between Sykes' and Jackson's wharves. It was found after a hard search.

My survey established the following facts: The present length of the canal from high-water on Mosquito Lagoon to high-water on Haulover Bay, Indian River, is 2,087 feet. The length of dredging required to establish a channel 4.5 feet deep in Mosquito Lagoon is 1,880 feet, and the same in Haulover Bay through the salt marsh, and in Indian River, is 5,020 feet.

The profile shows an extreme height of the natural surface of the ground above the bottom grade of the proposed canal of 12.60 feet with an average cut of about 10.50 feet. Rock is encountered for a distance of 1,370 feet in the cut, and averages 4 to 5 feet in thickness. In Indian River there is a rock cut of 1,170 feet, and averaging 4 inches in depth, required to obtain a depth of 4.5 feet at mean low-water. The water is lowered by the winds 2 feet below mean low-water, and sometimes raised to a height of 4.50 feet and probably more, during storms at the end of the rainy season.

PREVIOUS SURVEYS AT THE LOCALITY AND OBSERVATIONS.

I first visited this canal in February, 1869, in a tour through the State, making collections of natural history for the Museum of Comparative Zoology of Harvard University, Cambridge, Mass. At that time I camped upon its banks, and passed through it in a small boat with great difficulty. Then there were only a dozen settlers within a radius of 20 miles. Now there are over that number within 2 miles. The canal was little used, and had been suffered to become nearly choked up by the caving in of large masses of rock from the sides. At that time the small channel leading from the mouth of the canal to deep water in Mosquito Lagoon ran out in a southeast direction. It now runs out in a northeast direction. There was a low line of stone riprap extending nearly 100 yards into the lagoon, placed on the north side of the line of the canal produced, evidently intended as a jetty for the purpose of preserving a deep channel. This purpose, however, it failed to accomplish. There was no channel on the line of the canal, and the stones were nearly covered up by sand.

No trace existed of the channels included in the estimate of Lieutenant (now General) H. G. Wright, in his report to General Totten in 1853.

At low-water a shoal existed in front of the canal in Mosquito Lagoon.

In 1878 I passed through the canal on a reconnoissance for the Peabody Museum of Archæology and Ethnology of Harvard University. The canal had been cleared out by private parties, and would pass boats of 11 feet beam and drawing 16 to 18 inches.

The small channel in Mosquito Lagoon from the canal mouth to deep-water ran out in a northeast direction. The stone riprap on the north side of the axis of the canal had almost entirely disappeared, being covered up by the sand. Marsh grass was beginning to grow on the shoal at the east end, and there was a large shoal at the west end in Haulover Bay. In 1880 I again visited the locality, and made a survey in the vicinity, and observed the extreme low-water shown on the accompanying profile.

It appears by comparison of the 4 and 5-foot curves on the chart of comparative soundings, transmitted with the soundings taken on my survey, that those curves in Indian River have moved in about one-fourth of a mile nearer the shore than they were at the time the coast survey was made. The 4-foot curve now shows a depth of 5 feet, and the 5-foot curve a depth of 5.10. In Mosquito Lagoon the same action appears to be taking place.

The 4-foot curve now shows a depth of 5.6, and the 5-foot curve a depth of about 5.8.

The material brought out of the canal is plainly discernible in the contours of the bottom.

In comparing the soundings taken by Lieutenant Blake in 1845, the only benchmark available for comparison is the profile of the cut. His profile shows a height of 8.2 feet, at the highest point, above the water-line. Mine shows 8.10. From this it appears that the water was at about the same height as when his soundings were taken. From his chart it appears that the distance from shore to 4 feet of water in 1845 was 1,610 feet. In 1881 it was 1,675. In 1845 it was 2,100 feet out of 5 feet depth of water. Now it is 1,870 feet. This shows a slight increase in depth. The more rapid increase from the Coast Survey soundings is probably due to the washing away of the material brought out of the cut, which material appears to have been higher when the coast survey was made. It also appears by the surveys that a gradual waste of 4.62 feet per year has taken place in the eight years between Lieutenant Blake's and Lieutenant (now General) Wright's survey. In the twenty-eight succeeding years a loss of 2.25 feet per year is shown. This waste of the shore is confirmed by the position of the Coast Survey bench before referred to, and has been observed by me in many places in the vicinity, by reference to the government corners of the land surveys.

RESERVATION.

In October, 1880, I was appointed a United States deputy surveyor, and made a survey of a reservation 1,000 feet wide on each side from the center line of the canal, marking the boundaries with stone posts sunk in the ground and with earth mounds, as prescribed in the manual of instructions to the United States deputy surveyors.

This survey was accepted. It was not extended over the land of Andrew Jackson and none of his land was included in the reservation, by order of the Hon. Le Roy D. Ball, United States Surveyor-General.

I am informed, however, by letter of the 7th instant, from the Hon. N. C. McFarland, United States Commissioner of the General Land Office, "that as the canal is an important one" it has been decided to include this additional land in the reservation, and orders have been given for its survey.

The reservation was declared by proclamation of the President of the United States, August 26, 1880, and includes land held under the homestead act by Henry D. Sykes and William E. Futch, as shown on the plan of the canal accompanying this report.

These entries of land were made under the homestead law prior to the date of the order for reservation, and a "final certificate" has been issued to Henry D. Sykes, who has resided on the land and complied with the law. In the case of Wm. E. Futch, who had entered fractional section 30 under the homestead law before the order of reservation was made, he has built a house and set out an orange grove, and lived on and cultivated the land in good faith, as the law provides, but not long enough to have received a final certificate.

Andrew Jackson, over whose land the survey is to be extended, holds a patent from the United States for his land, under the homestead act.

As this land is held by law by the settlers, it is evident that the United States is bound to reimburse them for the land taken for right of way.

As no appraisement of the land has yet been made it is impossible to say what the amount of land damages will be, but from the nature of the improvements and the prices brought by other orange groves sold in the immediate vicinity it is probable that they will reach the sum of $10,000, even if they do not exceed it, including the land to be included in the reservation now belonging to Andrew Jackson.

For more particular data regarding the amount of land taken from each person, reference is hereby made to my plan of the "Haulover Canal Reservation, made by order of Le Roy D. Ball, United States surveyor-general of Florida, on a scale of 100 feet to 1 inch," and transmitted with my report and field notes of survey.

PREVIOUS EFFORTS BY THE INHABITANTS TO ESTABLISH A NAVIGABLE CHANNEL THROUGH THE HAULOVER.

In the spring of 1879 I was consulted by several of the most enterprising citizens of Titusville and vicinity, and particularly by Mr. H. F. Hammond, of Lake Worth, Fla., a gentleman owning a large cocoanut grove on the shores of that lake, and one much interested in the inland navigation on the east coast of Florida, upon the cost and feasibility of widening the existing passage to a width of 25 feet and a depth of 3 feet. Estimates were made based upon such data as was afforded by the United States Coast Survey charts of the inside passage, east coast of Florida, and the land maps of the locality, supplemented by a personal examination, and Mr. Hammond endeavored to obtain the gratuitous co-operation of the people living on the coast from Daytona on the Halifax River to Lake Worth; but while all agreed in the importance and desirability of the improvement, the attempt was unsuccessful, as it was the general belief that an adequate improvement, such as was demanded by the trade of the region, was beyond the power of private enterprise and the means of the people.

In the summer of 1880 several meetings of the citizens of Port Orange and Daytona were held at the latter place, to consider the widening of the present canal to a width of 25 feet and a depth of 3 feet.

A survey was made and estimates prepared of the contemplated work, and I was appointed a member of a subcommittee to collect contributions to enable the work to be done. The following circular and report of the engineer was printed and largely distributed among the people of the east coast, asking all to aid in the enterprise.

CIRCULAR.

"DAYTONA, FLA., *October* 30, 1880.

"We, the executive committee, appointed by a meeting of the citizens of the coast, for the purpose of taking steps to secure the opening of a navigable channel between Hillsboro' River and Indian River, would submit to you our plan of work and invite your cordial co-operation and aid.

"Annexed hereto you will find the report of a special committee appointed to survey and examine the proposed improvement, as well as their estimate of the cost, which is believed to be ample for the work.

"It is now proposed that subcommittees shall be appointed at each precinct on the Halifax, Hillsboro', and Indian rivers, to solicit subscriptions in either cash or specified parts of the work, and at the same time this circular will be sent to all who we believe will aid us.

"On the first Monday of December this committee will meet for the purpose of receiving the reports of the subcommittees on subscriptions, together with the responses from non-residents, when, if it is found that enough has been subscribed to make the improvement, the work will be pushed forward at once.

"It is fully believed by this committee, and was the unanimous sentiment of the meeting which appointed us, that, with this improvement made, the business of the country thus joined would be sufficient and ample to secure to the entire section that which we all need—*transportation*—as it would then pay both an outside and inside steamer.

"We trust that you will join with us in the work, and if so, that you will at once notify either member of the committee what amount you will subscribe, with the understanding that you will not be called upon for your subscription unless the full amount needed is subscribed, when you will be notified, and it will then be expected that you remit at once, so as to enable the work to be commenced and pushed to an early completion.

"WM. JACKSON,
"D. D. ROGERS,
"R. S. SHELDON,
Committee."

REPORT OF THE SPECIAL COMMITTEE.

"GENTLEMEN: The committee to whom was referred the matter of surveying and making a thorough examination, and calculating the probable cost of widening and deepening the Haulover Canal to the width of 25 feet and depth of not less than 3 feet, would most respectfully report to your committee that we have complied with your request, and we find it necessary to extend either end of the canal, on the lagoon side 1,400 feet, and Indian River, 2,400, making the total length of the canal 6,000 feet. We find it the most practicable to widen all on one side, and that the north; and in removing the rock we suggest it be placed on the line of the south side extended into the lagoon, as we find it necessary to build a breakwater, and we would respectfully recommend the same to your committee. The remaining distance of 400 to deep water on the lagoon on the south side, the north side opposite, and 1,200 feet from the marsh to deep water in Indian River, also the north side from the main land to the marsh, we would recommend to be piled with 'close piling,' good hard cabbage logs 10 to 12 feet long; between the last-mentioned places, on the south side, we recommend be filled with dredgings and loose rock, deposited a few feet off the true line and parallel with the same; either end of the canal we recommend be enlarged so that the entrance will be 50 feet in width.

"A synopsis of our calculation is as follows:

"Rock excavation	$400
"Sand " (above high-water)	600
"Dredging	1,900
"Piles, and driving same	600
"Total	3,500

"We have been liberal in our estimate, and believe that the work can be done for less, but it depends somewhat upon the manner in which the work is carried on, and have endeavored to remember the disadvantages that we are subject to. We believe the work to be practicable, and would recommend that the work be carried on at an early date.

"We are, yours, very respectfully,

"DAVID D. ROGERS,
"*Civil Engineer.*
"LAWRENCE THOMPSON.
"G. M. WALLACE.

"To the EXECUTIVE COMMITTEE
of the proposed improvement in the Haulover Canal."

This appeal met with indifferent success, as it was universally believed by the people that the estimates were much too small, and that the proposed width of 25 feet was inadequate to their wants.

It resulted in raising only a few hundred dollars, mainly contributed by parties desirous of running trade boats from Daytona to Indian River. This amount was expended in deepening the existing channel, removing fragments of the ledge that had fallen in and were obstructing the channel, and cutting away a few projecting points of rock, so as to enable a boat of 14-feet beam to pass through the canal under favorable circumstances.

I was also requested by the chairman of the meeting to correspond with the United States Engineer Department, to ascertain if the aid of the general government could not be invoked to assist the enterprise. In compliance with this request I addressed a letter to you upon the subject, and transmitted the information contained in your reply to the chairman.

Last spring Mr. J. M. Kreamer, the engineer of the Atlantic and Gulf Coast Canal and Okeechobee Land Company, made an examination of the isthmus in the interest of his company, between Indian River and Mosquito Lagoon, taking some borings, and reported in favor of a canal 44 feet wide at the base, with side slopes of 2 to 1. He thinks it will be necessary to have guard-gates or locks in the canal, to control the water when the levels of the respective lagoons are disturbed by the wind.

In 1879 a charter was granted by the State of Florida to Phineas D. Wesson and associates, of Titusville., Fla., under the name of the Haulover Tram Railroad Company, for a railroad across the divide for transporting boats and merchandise.

Nothing has ever been done by any of these companies.

IMPROVEMENT PROPOSED.

From the data obtained in the surveys and examinations, and from observation and study of the locality and an intimate personal acquaintance with the needs of the Indian River country, I respectfully recommend the following improvement:

The widening of the existing canal to a width of 60 feet on the bottom, and a depth of 4.5 feet below mean low-water of the United States Coast Survey, with side slopes in loose shell and sand of 2 to 1, and in rock cutting of ¼ to 1. The excavation to be mainly made upon the north side of the present canal. Both sides to be trimmed and sloped with the foregoing slopes, as shown on the three plates of cross-sections herewith transmitted.

The banks of the present canal are undermined by the action of the current in h formation of loose shell below the rock, in some places 6 to 8 feet.

For this reason, and to prevent subsequent caving and to straighten the canal on the south side, I recommend that the banks be trimmed and sloped and protected with riprap on both sides through the land cut, from the bottom of the canal to a height of 4 feet above mean low-water, with broken rock taken from the cut, except in places where the rock itself is sufficiently hard.

This is shown to be necessary by the action of the water in undermining the sides and washing away the banks, as it has done, until a cross-section, which was originally 12 feet at the water-level in 1853 through the sand cut, is now 25 and 26 feet. This material has been taken out by the current and deposited in a bar at both ends of the canal.

Owing to the very strong current, at times exceeding 2.8 miles per hour, flowing through the canal, sometimes in one direction and sometimes in the opposite, and the lateral exposure to the sweep of the prevalent very strong north winds, making navigation by boats or other vessels with much top hamper through the canal difficult, I have given the canal somewhat larger dimensions than I otherwise would. Rankin's formula, "*greatest width of boat* × 2," gives results larger than would be absolutely required in this place were it not for the oftentimes strong current and the other conditions mentioned as existing. The shorter time required to produce an equilibrium between the lagoons with a large cross-section should also not be overlooked. It is confidently believed that upon the opening of this canal a line of steamers will be at once put on to traverse between Daytona and other points on the Halifax and Indian rivers, connecting with a steamer at Port Orange or New Smyrna from Jacksonville or Savannah. These steamers would probably have a beam of 25 to 30 feet and draw 3 to 4 feet when loaded, and a depth of 4.5 feet below Coast Survey datum is consequently recommended for the canal to make it navigable at the lower stages of water. Several steamboatmen with whom I have conversed are desirous of establishing such a route as soon as the canal is opened. Dredging of the same width and depth will be required in Mosquito Lagoon for a distance of 1,880 feet from shore, as shown on the profile transmitted, and through Haulover Bay and in Indian River for a distance of 5,020 feet from the west end of the land cut. The material to be dredged is sand and finely comminuted shells. There will be a rock cut in the bottom of the dredged channel in Indian River for a distance of 1,170 feet, averaging about 4 inches in depth.

These dredged channels in Mosquito Lagoon and Indian River will require parallel submerged jetties to be placed 100 feet apart to keep them open. These jetties I recommend to be carried out to a depth of 5.8 feet in Mosquito Lagoon, which will give a length of 2,120 feet.

In the Haulover Bay I think the jetties can be dispensed with, and would substitute a cross-dam, 610 feet long, across the narrowest place in the bay, just south of the canal, and in the position shown on the accompanying plan.

In Indian River, beginning at the west shore of the marsh, parallel submerged jetties will be required, of a length of 4,050 feet, or to a depth of 4.8 feet, as shown.

These jetties are shown to be necessary by the action of the water in filling the cuts mentioned by Lieutenant (now General) H. G. Wright, in his report before referred to. I am also informed by the residents in the vicinity that channels have frequently been dug out in the lagoon and Haulover Bay, but they were quickly filled up, and no trace of them exists to-day.

Among these is the channel said to have been dug in Haulover Bay to float the Coast Survey sloop Steadfast, which was hauled across the isthmus in 1875.

The *single line* of riprap thrown down on the north side of the canal axis in the lagoon was an imperfect and quite inadequate attempt at jettying, and it is not surprising that it was a failure. There is probably no littoral current in either Indian River or Mosquito Lagoon at this locality, but the long reaches of shoal water extending out from each shore are subject to violent wave action on a small scale, during the prevalence of "northers," and other strong winds, which it is believed would certainly soon fill any unprotected cut, especially when it is remembered that the prevailing winds are from the north and southeast, nearly transverse to the necessary line of the cuts.

The sand-bars forming at the ends of the canal are unquestionably composed of material washed from the banks of the canal.

With the banks protected by riprap, and with a bottom of loose rock or hard shell, as is generally the case through the present cut, I do not think much material will be found for the current to transport and deposit in bars at the ends of the jetties.

If, in time, however, such should prove to be the case, it might be necessary to further protect the bottom and sides with riprap. I have observed, however, that such bars are generally formed some little distance from the ends of the jetty, or where the water begins sensibly to lose its velocity. In deep water this leaves a channel on the right or left side, or both, between the jetty end and the deposit, with an abrupt turn into the canal.

The fact that there will be abundance of stone in the excavated prism of the canal to build these jetties, which would otherwise go to waste, reduces the cost of them very much.

I have estimated for jetties built of close-driven double row of palmetto logs, averaging 10 feet long, cut off 1 foot below mean low-water, and find that jetties of this description will cost much more than the mattress and stone jetty, such as you are so successfully using at Saint John's Bar, Volusia Bar, and other places, provided the stone used is taken from the cut. This is estimating the piles at 40 cents each, delivered, and 40 cents apiece additional for driving—a low estimate; but I was informed by reliable parties there that they would enter into a contract to supply them at that price, and some parties mentioned even lower figures. An ordinary wood-chopper can fell and cut into 10-foot lengths 70 to 80 such piles in a day, as has been done on Indian River by persons building wharves. On the Indian River end piles cannot be driven on account of the rock.

This coquina rock is nearly of the specific gravity of limestone, and in *this locality* will, in my opinion, answer as well as any.

Pine logs or palmetto logs can be obtained for mattresses on the west side of Indian River, a distance of 5¼ or 6 miles, and abundance of brush can be obtained within a couple of miles of the canal on the isthmus.

There will be 14,972 cubic yards of rock excavation. Of this, 1,665 cubic yards will be taken from the dredged channel between the jetties on Indian River.

I have estimated the jetties in Mosquito Lagoon at a width of 6 feet at the shore end and 14 feet at the outer end. In Indian River, where the jetties are less exposed to long reaches of the prevailing winds, I have estimated them with a width of 6 feet at the shore ends, and 12 feet at the outer ends, and for the cross-dam I consider 8 feet in width to be ample in so sheltered a position.

At these widths there is required for the

	Cubic yards.
Mosquito Lagoon jetties, stone	1,836.3
Indian River jetties, stone	3,086.2
Cross-dam jetties, stone	180.7
Making a total of stone of	5,103.2

Of this amount, 1,665 cubic yards will be taken from the cut between the jetties, and it will be only necessary to lay it upon the mattresses.

There will be apparently a surplus of 9,868.8 cubic yards of stone more than is required for the jetties and cross-dam, estimating for only one course of mattresses, 30 inches thick, and the top of the jetty to be 1 foot below level of mean low-water, where deep enough, except at the cross-dam, which should be one-half foot above mean low-water.

The actual surplus, however, after deducting 971.9 cubic yards for riprap, owing to the friable and decomposed character of much of the rock, will be probably very little if any. The dredgings and this shell and disintegrated rock can be advantageously placed on the back or outside of the jetties, serving to strengthen them and rendering the dimensions assumed above ample. Some of it can be used to advantage also to protect the sides of the dredged channels.

The character of the rock is such that very little, if any, will require blasting. Where covered with water or damp earth, it is soft and can be easily cut out with an ax or dislodged with picks. Upon exposure to the atmosphere, however, it becomes very hard. I do not believe that any guard-gates or locks will be required in the canal. It would be advisable, however, to make a tow-path on one side, at top, in order that boats and sailing vessels may be towed against the current, which, as a general rule, seldom runs in the same direction more than two or three days at a time, and then is only strong enough to cause trouble during the prevalence of very severe northers or long-continued strong southeast winds, except in floods or after a cyclone.

If in the future it is found that locks are required they can be built as well as now. In view of the character of the rock, and the fact of the existence of the present cut, presenting a continuous face for work and allowing narrow scows to load directly from the bank, I think my estimates herewith presented are ample, and will not be exceeded

ESTIMATE OF COST.

Earth-work:		
Excavations of sand and shell between Mosquito Lagoon and Indian River, 37,892 cubic yards, at 20 cents		$7,578 40
Dredging in Mosquito Lagoon, 10,689 cubic yards, at 20 cents		2,137 80
Dredging in Indian River, 21,445 cubic yards, at 20 cents		4,289 00
		14,005 20
Rock-work:		
In Indian River, 1,665 cubic yards, excavated and placed on jetty, at $2	$3,330 00	
Between Indian River and Mosquito Lagoon, ditto, 13,307 cubic yards, at $1.50	19,960 50	
		23,290 50
Mosquito Lagoon jetties:		
4,711.1 square yards mattress 30 inches thick, at $1		4,711 10
Indian River jetties:		
8,100 square yards 30 inches thick, at $1		8,100 00

Cross-dam:	
542.22 square yards mattress, 30 inches thick, at $1	$542 22
Riprap:	
971.9 cubic yards laying, one-half from dump and one-half taken from cut, at 20 cents	194 38
	50,843 40
Contingencies and superintendence, 10 per cent	5,084 34
	55,927 74
Add for land damages, approximated	10,000 00
Total	65,927 74

It is recommended that palmetto logs be used in the mattresses, and mangrove brush or saw palmetto, all of which are very abundant, in the place of oak brush, to avoid injury from worms. This will insure permanency in the work.

The best method of doing the work will be, to first build the mattresses in position and load them with only sufficient stone, taken from the cut at the time, to sink them. After the mattresses are all laid the dredging and excavation can go on simultaneously and the mattresses be loaded with their full quota of stone, and the top of the jetties brought up to grade. Half the stone required for riprap will have to be dumped—that is, the riprap required for the north side of the land-cut—and taken from the dump and laid upon the completion of the side slopes on the north side. The other half can be laid upon the south bank, it only being necessary to throw it across the old canal, if the slopes of the south bank are trimmed first.

The best time of year for doing the work would be from November 1st to May 1st. After the latter date the mosquitoes would be found very troublesome, and during June, July, August, and September almost unbearable. This place has the reputation of being the worst for mosquitoes on the whole east coast, and my experience confirms it.

The work would require the best part of two working seasons to complete.

COUNTRY AND POPULATION TO BE BENEFITED.

The country to be directly benefited by the construction of this canal embraces the whole of the east coast south of the canal and to the southern extremity of Lake Worth, a distance of 160 miles. The coast country north of the canal to the northern extremity of Bulo's Creek, a distance of 60 miles, will be also indirectly benefited, inasmuch as with this canal opened for steamboat navigation a sufficient amount of freight could be collected at Mosquito Inlet to amply repay a regular line of steamers from that inlet to Savannah or Jacksonville, a condition of things that without it does not exist.

The population of the east coast south of this canal to the lower extremity of Lake Worth, as given by the last census, is about 1,600. The population north of the canal that would be indirectly benefited is about 1,800. This population is constantly increasing, and the country only needs an outlet for its productions to encourage planters and enable it to receive a large share of the great immigration now entering the State.

Abundance of good land awaits the settler on Indian River, and the oranges from this section already have the highest reputation of any in the State. There are thirteen stores below the canal on Indian River, and eight post-offices.

As this region is comparatively unknown and generally supposed to be given over to alligators and mosquitoes, I will quote from my report on the Indian River and tributary country, made in 1880 to the Saint John's and Indian River Railroad Company. It appears that at that time there were the following orange groves and other plantations on the Indian River and at Lake Worth, viz:

"Two hundred and four orange groves, containing 87,000 trees, of which 15,000 are now bearing. There are 220,000 pineapples, of which one-half are at Lake Worth, and about half this number of bananas.

"There are 20 cocoanut groves at Lake Worth, containing 12,000 cocoanut palms.

"To these should be added an almost innumerable number of guavas, limes, lemons, and various other tropical fruits, such as sugar apples, mangoes, olives, dates, grapefruit, grapes, West Indian pappaw, sapodillo, cherimoyer, &c., &c.

"Large amounts of sugar-cane, sweet and Irish potatoes, early tomatoes, and other early vegetables are raised, and the vegetables are ready to be shipped to the North in February and March."

The present amount of trade to and from Indian River is very difficult to determine with accuracy. Blanks to be filled out with the amounts of freight carried by the steamers on the Upper Saint John's above Enterprise, for the last year, have been sent by me to the steamboat owners whose vessels ply on that route, but have remained unanswered. Some of the Indian River freight is sent via New Smyrna and Mosquito

Inlet and passes through the existing Haulover Canal, but the larger part, at present' crosses the divide from Indian River to the Saint John's, either at Titusville to Salt Lake Landing, on the Saint John's, or at Rock Ledge to Lake Poinsett Landing, and follows the devious channel of the Upper Saint John's to Jacksonville, occupying from 50 to 70 hours in transit.

The Salt Lake and Titusville Branch of the Saint John's and Indian River Railroad, 7.3 miles long, from Salt Lake to Titusville, was never laid except with temporary wooden rails and operated with mules. It is now worn out and disused, and all freight is hauled over in wagons.

In regard to the amount of productions of this region, I will quote from another report, prepared by me for the Sanford and Indian River Railroad Company, in February, 1881, on the subject of Indian River trade:

"There were shipped last year (1880) 2,000,000 oranges, equal to about 14,000 boxes. This was an unfair year for a criterion, as fully one-half the crop was blown from the trees and destroyed in the cyclone that visited that section before the oranges were ripe.

"Early vegetables, mostly tomatoes, boxes shipped	1,000
"Bananas, bunches	500
"Irish potatoes, barrels	200
"Sirup and sugar, barrels	400
"Green turtles, caught and shipped	600
"Pineapples, about	50,000
"Lemons, crates	100
"Limes, crates	50
"General merchandise, tons	700

"About 75,000 pine apples are expected to be shipped from Lake Worth this year."

This Lake Worth freight all comes via Indian River.

It is believed that nearly all the above freight would pass through the Haulover Canal, in preference to the rehandling, teaming, and extra time required by the Saint John's route, if it was opened to allow steamboat travel.

Indeed, steamers drawing 3 feet have been brought to the eastern end of the canal in Mosquito Lagoon to collect the oranges from the Dummett Grove, now belonging to the Duke de Castellucia, the production of which varies from 40,000 to 100,000 oranges and over per year.

The great desirability of this improvement and the imperative need of this section for better transportation, to furnish an outlet for their rapidly increasing productions, is greatly enhanced by the perishable natures of the freight. These orange groves and other plantations are constantly and rapidly increasing. Only about one-sixth of the orange trees are as yet bearing, and the same is true of the other fruits. This entire east coast is destined, at no distant day, to support a large and prosperous population, and will present almost one continuous orange grove.

The craft at present navigating Indian River is confined to sail-boats, sloops, and small schooners, which have mostly been built on the river. There are five small schooners averaging from 40 to 45 feet long and 10 to 14 feet beam. One of these vessels makes semi-regular trips outside, from Jacksonville to Indian River Inlet with freight, being unable to pass through the present canal. The United States mail is all carried in boats on this river, and is brought from Saint Augustine via Daytona, and all passes through this canal, where it is often subject to great delay.

This little cut forms an important factor in the inland coast navigation scheme for inland water communication from Saint Augustine to Biscayne Bay, which has engaged the attention of the government for many years, and the many advantages and benefits of which to commerce, navigation, and the people of the east coast of Florida it would be superfluous for me to recite.

This work is in the collection district of Saint Augustine, and Saint Augustine is the only port of entry in the district. I inclose statement of the collector of customs regarding the amount of revenue collected.

The work can be done most advantageously to the United States by contract.

The nearest fort is Fort Marion, at Saint Augustine.

The nearest light-house is Cape Canaveral.

I transmit with this report the following plans and drawings:

1 chart of comparative soundings.
1 plan of canal and reservation.
1 profile of proposed work.
3 sheets of cross-sections.

The plans and papers sent me are herewith returned.

Very respectfully, your obedient servant,

J. FRAS. LE BARON,
Assistant Engineer.

Bvt. Maj. Gen'l Q. A. GILLMORE,
Lieut. Col. of Engineers, U. S. A.

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, SAINT AUGUSTINE, FLORIDA,
Collector's Office, September 5, 1881.

SIR: I have the honor to acknowledge the receipt of your letter of the 1st instant, relative to the amount of revenue received at this port for the fiscal year of 1881, and very respectfully report as follows:

Received for duties on imports	$2 40
Received on account marine-hospital tax	63 64
Received on account tonnage tax	57 30
Received on account official fees	31 90
Received on account fines, penalties, &c	5 75
Received on account steamboat inspection	50 00
Exports to foreign ports:	
160 head of cattle, valued	3,300 00
Number of vessels entered and cleared (not including those within this district and Jacksonville)	22

The imports for the fiscal year of 1881 were unusually small; the imports for the fiscal year of 1880 were $125.15.

Very respectfully,

THOMAS F. HOUSE,
Collector.

J. F. LE BARON, Esq.,
United States Assistant Engineer.

APPENDIX K.

IMPROVEMENT OF THE HARBORS OF MOBILE, ALABAMA, AND OF PENSACOLA AND CEDAR KEYS, FLORIDA; OF TAMPA AND APALACHICOLA BAYS, FLORIDA, AND OF CERTAIN RIVERS IN GEORGIA, ALABAMA, FLORIDA, AND MISSISSIPPI EMPTYING INTO THE GULF OF MEXICO.

REPORT OF CAPTAIN A. N. DAMRELL, CORPS OF ENGINEERS, BVT. MAJOR, U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. **Mobile Harbor, Ala.**
2. **Pensacola Harbor, Fla.**
3. **Chattahoochee River, Ga. and Ala.**
4. **Flint River, Ga.**
5. **Apalachicola River, Fla.**
6. **Apalachicola Bay, Fla.**
7. **Tampa Bay, Fla.**
8. **Suwanee River, Fla.**
9. **Choctawhatchee River, Fla.**
10. **Withlacoochee River, Fla.**
11. **Peas Creek, Fla.**
12. **Escambia River, Ala. and Fla.**
13. **Alabama River, Ala.**
14. **Warrior and Tombigbee rivers, Ala.**
15. **Tombigbee River above Columbus, Miss.**
16. **Noxubee River, Miss.**
17. **Pascagoula River, Miss.**

EXAMINATIONS AND SURVEYS.

18. **Finhollaway River, Fla.**
19. **Aucilla and Wacissa rivers, Fla.**
20. **Chipola River, Fla.**
21. **Ocolockonne River, Fla.**
22. **Holmes Creek, Fla.**
23. **East Bay and Blackwater River, Fla.**
24. **Tombigbee River, Miss., from Fulton to Warren's Mill.**
25. **Dog Island Harbor; Harbor of Key West; Crystal River; La Grange Bayou, up to Freeport; Manatee River and Crooked River, Fla.**
26. **Outlet of harbor of Ship Island.**
27. **Harbor at Biloxi, Miss.**
28. **Harbor at Pascagoula, Miss.**
29. **Old Town Creek, Miss.**

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., August 19, 1882.

GENERAL: I have the honor to transmit herewith annual reports for the year 1881–'82 for the river and harbor improvements under my charge.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

K 1.

IMPROVEMENT OF THE HARBOR AT MOBILE, ALABAMA.

The improvement of the channel of Mobile Harbor by the General Government was begun in 1827, the depth being at that time 5½ feet through Choctaw Pass and 8 feet on Dog River Bar. Up to 1857 the amount of $228,830.60 had been appropriated, and the result obtained was a channel 10 feet deep and 200 feet wide through the "Pass," and the partial dredging of a channel 10 feet deep, with an unknown width, through Dog River Bar. In 1860 the cut through Choctaw Pass had shoaled to 7½ feet depth, while that through Dog River Bar remained unchanged. No further improvement by the General Government was attempted until 1870.

From 1870 to 1875 the amount of $401,000 was appropriated, and the work accomplished was a channel 13 feet deep, 300 feet wide, from the mouth of Mobile River, through Choctaw Pass, and a channel of same depth 200 feet wide through Dog River Bar, with its southern entrance about 8½ miles from the mouth of Mobile River. Since 1875 there has been no perceptible change in depth on either bar.

In 1878 a survey, also tests and borings, were directed to be made in order to determine whether the existing 13-foot channel could be so deepened and depth maintained as to admit to the wharves of the city vessels drawing not more than 22 feet, and for this purpose the sum of $10,000 was appropriated by an act of Congress approved June 18, 1878.

From the results of the surveys and borings, a report was made to the Chief of Engineers, suggesting several different plans of improvement.

It was finally decided to dredge the existing 13-foot channel to the depth of 17 feet, with a uniform width of 200 feet, from the 17-foot curve in Mobile River to the extreme northern point of the curve of same depth in the lower bay, the estimated cost of the improvement being $820,000.

Congress, by an act approved March 3, 1879, having appropriated $100,000 for the above improvement, bids were called for and opened May 20, 1880, but all were rejected as excessive (the lowest being 24.9 cents), and the work ordered to be readvertised. Congress, in the meantime, by act approved June 14, 1880, having appropriated an additional $125,000, bids were called for on a basis of $225,000, the contract was awarded to George C. Fobes & Co., of Baltimore, Md., their bid (12.3 cents) being the lowest (see abstract of bids hereunto annexed), and the date of commencement fixed upon was December 29, 1880.

The contractors not then being ready, an extension was granted to February 1, 1881.

The condition of the channel previous to the commencement of the present improvement was such that vessels drawing over 12½ feet could not reach the wharves of the port, or ascend the bay beyond the lower anchorage, 28½ miles distant, at mean low-water. From the mouth of Mobile River to Fowl River Shoals (except between the obstructions) the depth of water nowhere exceeded 13 feet, being uniformly of that depth until the above shoals were reached, a distance of 18 miles from the city. On these shoals the depth varied from 12½ to 13 feet. From this point, going south, there is a plateau with 13½ feet water extending to within 4 miles of the southern entrance of the projected 17-foot channel, and then the depth gradually increases to the 17-foot curve.

In addition to the above, there are two wrecks, one a small steamboat, 40 feet below the lower gap light, loaded with ballast, extending 30 feet into the channel on the east bank; the other a brig, loaded with ballast, about 150 feet south of the first and entirely in the channel. These will have to be removed, and are the only obstructions of this character at present known.

The nature of the material to be dredged is hard sand, in the mouth of the river; then comes a mixture of sand and clay, through Choctaw Pass, to a point east of Dog River. Here is to be found a sand-bar, varying from 1½ to 2½ feet in thickness, overlying a clay substratum. From this point until Fowl River Shoals are reached the material is a blue clay, entirely free from sand or alluvial deposit.

The Fowl River Shoals are composed of oyster reefs, which here and there crop out, and again are covered from 3 to 5 feet with a clay mixed with small shell. From Fowl River Shoals the material is a very soft blue mud and clay.

Two alterations have been made in the original project.

1. On account of the short bends at the mouth of the river and at the upper gap it was deemed advisable to make the channel through Choctaw Pass, a distance of 3,820 feet, at least 300 feet wide, and the portion below the obstructions, for a distance of 5,703 feet, a width of 250 feet.

2. In order to straighten the channel the line of the 13-foot channel (S. 11″ E. mag.) was continued to a point just south of Fowl River Shoals, 16.44 miles distant from the north entrance; at this point an angle of 12° 40′ to the right was made, and the channel (S. 1° 40′ W. mag.), so located that the extreme northern point of the 22-foot curve (about three-quarters of a mile from south end of the 17-foot curve) was reached instead of that of the 17-foot curve, thus obviating any further change should the depth be increased to 22 feet.

The contractors, George C. Fobes & Co., commenced work February 19, 1881, and at the end of the fiscal year 1880–'81 had dredged one cut 35 feet wide from the mouth of Mobile River to buoy Number 5, a distance of 3.5 miles; also a second cut, commencing at the upper gap of the "Obstructions," increasing the width to 70 feet a distance .57 mile, making total distance dredged 4.07 miles, and material removed 143,149 cubic yards.

During the first quarter of the fiscal year 1881–'82 the progress of the work was very slow. On October 13 the contractors placed an additional dredge on the work, which considerably increased their estimates, yet they had only accomplished about one-quarter of their contract at the expiration of the time of completion, December 29, 1881. A conditional extension was granted them to June 30, 1882. They commenced working at night with one dredge February 27, 1882, and on May 20 a third dredge was started, also working day and night. The contractors anticipate completing their contract by October 1, 1882.

By act of Congress approved March 3, 1881, an additional sum of $100,000 was appropriated to this improvement. Bids were opened July 9, 1881, and contract awarded to Mr. G. L. Long, at 11.7 cents per cubic yard (see abstract of bids hereunto annexed).

The contractor commenced work March 21, and is working night and day, making good progress.

The following is a statement of the progress of the work during the fiscal year ending June 30, 1882:

		Cubic yards.
Cut No. 1. Width, 40 feet;	length, 14.19 miles	580,881
Cut No. 2. Width, 35 feet;	length, 10.96 miles	387,498
Cut No. 2. Width, 40 feet;	length, 7.62 miles	347,225
Fiscal year 1881–'82	32.77 miles	1,315,604

WORK UNDER THE CONTRACT OF GEORGE C. FOBES & CO.

		Cubic yards.
Cut No. 1.	14.19 miles	580,881
Cut No. 2.	12.01 miles	428,408
	26.20 miles	1,009,289

WORK UNDER CONTRACT OF G. L. LONG.

		Cubic yards
Cut No. 2.	6.57 miles	295,315

The channel has been staked in the following manner: From the mouth of Mobile River to the 18-foot curve, a distance of about 27 miles, clusters of five piles, with platform, were built as near as possible every half mile, and between these clusters are four intermediate piles 500 feet apart.

This line is located on the east side of the channel and 15 feet from bank of same. To the west, at least 1 mile distant, stations of three piles, with platform, were built for the purpose of triangulating and to mark the limits of the dumping-ground.

The cost of this work was as follows:

199 single-line piles, at $4	$796 00
49 five-pile line clusters, at $40	1,960 00
1 nine-pile angle cluster	72 00
1 five-pile angle cluster	43 30
21 triangulation stations, at $25	525 00
1 triangulation station, rebuilt	25 00
3 single-line pile, at $4	12 00
Total cost	3,433 30

The following was the condition of the improvement June 30, 1882:

From the 17-foot curve in the Mobile River to the upper gap of the "Obstructions," a distance of 3,820 feet, there is a single cut of a minimum width of 35 feet and minimum depth of 17 feet at mean low-tide, except where refilling took place, referred to further on in this report. At this point a double cut, having same depth, with a minimum width of 75 feet, which is complete as far as cluster No. 38, a distance of 19.35 miles, with the following exceptions, viz, from 1,660 feet south of cluster No. 22 to cluster No. 25, 1.22 miles.

From 1,710 feet south cluster No. 29 to cluster No. 37, 3.68 miles. Between these respective clusters there is at present only a single cut, having a width of 40 feet.

From cluster No. 38 a single cut of same width extends 1,265 feet south of cluster No. 40, a distance of 1.27 miles, making total length of connected channel 21.36 miles.

The third dredge of George C. Fobes & Co., which commenced work on May 20, 1882, was placed at cluster No. 41, 1,479 feet south of the end of the completed portion, and a distance of 1.05 miles has been dredged.

Total length of double cut June 30, 1882, 14.44 miles.

Total length of single cut June 30, 1882, 7.94 miles.

Before the improvement was commenced all vessels of greater draught than 13 feet were compelled to anchor in the lower bay, 28½ miles from the city, and their cargoes, in and out, were lightered to and from the city, thus entailing great cost and loss of time.

Since the improvement has been completed to the 13½-foot curve (which is south of the Fowl River Shoals), vessels drawing from 14 to 15 feet can, with a medium tide, proceed directly to the wharves, shown in the case of the bark William Wright, tonnage 752, drawing 14.8 feet, which entered April 27, 1882, landing at the Mobile and Ohio Railroad wharf, in the northern part of the city, and cleared June 15, 1882, loaded with lumber, and drawing 14.2 feet water.

Other barks and ships which have heretofore remained at the lower anchorage have reached the city this spring. The channel is, therefore, available for vessels of less draught than 15 feet.

It is proposed to apply the funds available for expenditure during the fiscal year ending June 30, 1883, to completing to the lower anchorage the two cuts now being dredged; to finishing that portion of cut No. 2 remaining to be dredged from the mouth of the river to the upper gap; to redredging that portion of cut No. 1 in the Mobile River which has been refilled for a distance of 1,610 feet; to removing the wrecks at and near the lower gap of the "Obstructions," thus affording a clear and unobstructed channel of a minimum depth=17 feet at mean low-tide, and of minimum width=75 feet to the wharves of the city.

It is expected that this will be accomplished by October 1, 1882. It is further proposed to apply whatever balance there may then be unexpended toward increasing the width of the channel by a third cut, and to continue said cut until the funds available are exhausted. The channel of 17 feet depth and 75 feet minimum width will allow all vessels drawing less than 17 feet to come to the wharves of the city at mean low-tide.

The sum of $370,000 can be profitably expended during the fiscal year June 30, 1884, and it is proposed to use said amount toward increasing the width of the 17-foot channel. At present prices per cubic yard the above amount will increase the existing width to at least 200 feet.

The estimated total cost of the improvement was $820,000.

The appropriations already made are as follows:

By act approved March 3, 1879	$100,000
By act approved June 14, 1880	125,000
By act approved March 3, 1881	100 000
	325,000
By act passed August 2, 1882	125,000
	450,000
Estimated cost	820,000
Total appropriations	450,000
Amount required for completion	370,000

This amount will complete the channel according to the original project, will widen those portions intended to be increased, and will also sufficiently widen the channel at all the bends so as to permit vessels to make the turns without difficulty.

There is but one point in the channel so far dredged that has shown any shoaling or the slightest tendency to do so, viz, in the mouth of Mobile River, where the narrow cut of 35 feet was found to have refilled when sounded after a very severe northeast storm.

The distance filled, 1,610 feet. This same trouble was met with when the 13-foot channel was dredged, but when opened to the full width of 300 feet this tendency ceased, and there has been no shoaling at this point since, the depth of 13 feet being maintained without any further dredging, and it is confidently believed that the same results will attend the opening of the 17-foot or even a 22-foot channel to the full width of 300 feet.

The character of the channel already dredged would seem to indicate that from Choctaw Pass down the improvement is permanent, that it will not require an annual and possibly not a periodical appropriation of any amount in order to maintain the depth; and, further, the permanency of the 13-foot channel at the mouth of the river renders it very doubtful whether any appropriation will be needed to maintain the depth there.

The improvement is located in the collection district of Mobile. Mobile is the nearest port of entry.

The following statistical statement of the commerce of Mobile for the fiscal year ending June 30, 1882, was furnished by the collector of customs at this port:

Entrances and clearances port of Mobile.

ENTRANCES.

Arrivals.	June 30, 1881.		
	Vessels.	Tonnage.	Crew.
Foreign	99	69, 019	1, 492
Coastwise	57	20, 606	376
American	40	14, 982	454
Total	196	104, 607	2, 322

CLEARANCES.

Foreign	72	64, 679	1, 384
Coastwise	54	18, 690	497
American	46	17, 777	400
Total	172	101, 146	2, 281

June, 1881.

Duties on imports	$226, 116	59
Tonnage dues	16, 854	00
Hospital collections	2, 803	77
Miscellaneous	12, 407	74
Total collections	258, 182	10
Exports to foreign ports	$6, 594, 840	00
Imports, foreign goods	659, 397	00

It is impossible to make an approximate estimate of what may be the probable increase of commerce of the port of Mobile by the completion of the improvement now under way.

The great security that her harbor affords shipping of any draught of less than 24 feet; the geographical position of the port on the Gulf; the proximity to the West Indies and South America; the vast mineral resources of the State of Alabama, of which Mobile is the chief city and only port of entry; also the close rail connections with all the important cities of the West and North, render it absolutely certain that so soon as the shipping facilities are so increased as to allow vessels of heavy draught to load and unload at her wharves the commerce must increase to a vast extent.

Money statement.

July 1, 1881, amount available		$302,361 21
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$170,389 62	
July 1, 1882, outstanding liabilities	16,695 31	
		187,084 93
July 1, 1882, amount available		115,276 28
Amount appropriated by act passed August 2, 1882		125,000 00
Amount available for fiscal year ending June 30, 1883		240,276 28
Amount (estimated) required for completion of existing project		370,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.		370,000 00

Abstract of bids received and opened August 26, 1880, *relating to dredging in Mobile Harbor, Alabama.*

No.	Name of bidder.	Price per cubic yard.	Time of commencing work.	Time of completing work.
1	Wm. A. Alexander	$0 15.85	Three months after notification of approval of contract.	One year from date of commencement.
2	James E. Slaughter	14.6	......do	Do.
3	O. J. Jennings	19¼	......do	Do.
4	American Dredging Company	23	......do	Do.
5	National Dredging Company	13	......do	Do.
6	Geo. C. Fobes & Co	12.3	......do	Do.
7	James G. Stewart	19.4	......do	Do.
8	George Kellogg	19⅛	......do	Do.

Abstract of bids received and opened July 9, 1881, *for dredging in Mobile Bay, Alabama.*

No.	Name of bidder.	Price per cubic yard.	Time of commencing work.	Time of completing work.
1	James E. Slaughter	$0 13.7	Three months after notification award contract.	One year from commencement of work.
2	George C. Fobes & Co	12.4	......do	Do.
3	S. N. Kimball	16.9	......do	Do.
4	John Maguire	14	......do	Do.
5	W. Fagan	12	......do	Do.
6	G. L. Long	11.7	......do	Do.

The work of each dredge compared.

	Dredge Mobile, of Geo. C. Fobes & Co.	Dredge Colonel Craighill, of Geo. C. Fobes & Co.	Dredge Alabama, of Geo. C. Fobes & Co.	Dredge T. H. Herndon, of G. L. Long.
Date of commencement	Feb. 19, 1881	Sept. 21, 1881	May 20, 1882	Mar. 21, 1882
Total number of cubic yards removed, 1881–'82.	420,074	569,647	40,910	298,650
Total number of cubic yards deducted, 1881–'82	16,378	3,964	....	2,335
Total number of cubic yards paid for, 1881–'82	403,696	565,683	40,910	296,315
Total distance dredged ....feet	59,347	73,202	5,561	34,688
Total number days (12 hours) actual work	249	115⅓	....	22
Total number days (24 hours) actual work	....	77¼	....	50⅝
Total number days lost due to weather	10¾	9¾	....	11⅛
Total number days lost due to other causes	53¼	18	....	3
Average daily distance (12 hours) ......feet	238.3	210.5	....	293
Average daily distance (24 hours) ..... do	....	637.2	....	550.9
Average daily material removed (12 hours)	1,687	1,875.4	....	2,418
Average daily material removed (24 hours)	....	3,257.2	....	4,813

COMMERCIAL STATISTICS.

Miscellaneous.		Value, 1882.	Value, 1881.
Fish and oysters		$157,500	$150,000
Vegetables		437,267	174,483
Wool	pounds	450,000	325,786
Alabama coal	tons	19,062	8,189
Pennsylvania and English coal	do	1,108	2,701
Bagging	rolls	13,770	9,257
Cotton-ties	bundles	41,154	42,315
Bacon	casks	9,216	8,829
Flour	barrels	80,428	90,013
Molasses	do	5,988	5,773
Sugar	hhds	4,277	4,035
Whisky	barrels	6,613	7,954
Pork	do	1,888	1,874
Fertilizer	sacks	59,530	57,062
Corn	do	255,709	345,307
Bran	do	42,945	43,996
Hay	bales	22,339	27,490
Tobacco	boxes	17,968	17,404

Mobile cotton exchange statistics.

		1882.	1881.
Cotton receipts:			
Via Alabama River	bales	39,692	46,434
Via Tombigbee River	do	45,404	66,966
Via Warrior River	do	964	15,638
Via Mobile and Ohio Railroad	do	123,568	159,575
Via Mobile and Montgomery Railroad	do	59,469	98,231
Via coastwise	do		
Totals			386,844
Coffee importations	sacks	23,332	18,848
Naval stores:			
Rosin	barrels	160,971	154,837
Turpentine	casks	25,314	22,549
Tar	barrels	440	400
Pitch	do	2,750	2,500
Salt:			
Imported from Liverpool direct	sacks	28,398	77,627
Imported from Liverpool indirect	do	8,588	7,000
Imported coastwise Vermillion Bay	do	75,557	18,011
Other points	do		2,000
Totals		112,543	104,638

Comparative statement of lumber and timber shipments to foreign and coastwise ports for 1881 and 1882.

		1882.	1881.
Lumber:			
Foreign	feet B. M.	27,805,777	11,531,246
Coastwise	do	6,951,444	9,587,562
Interior	do	5,000,000	4,500,000
Total		39,757,221	25,618,808
Timber:			
Foreign	do	17,097,160	20,326,056
Coastwise	do	4,274,290	131,832
Interior	do		
Total		21,371,450	20,457,888
Shingles:			
Foreign	number	1,848,450	3,900,250
Coastwise	do	1,789,300	2,160,000
Interior	do	10,832,000	
Total		14,469,750	6,060,250

Comparative statement of lumber and timber shipments, &c.—Continued.

		1882.	1881.
Staves:			
Foreign	number..	97,926	91,462
Coastwise	do....	4,800	....
Interior	do....	7,200	....
Total		109,926	91,462
Laths:			
Foreign		....	....
Coastwise		....	256,000
Interior		....	....
Total		....	256,000

Number and character of vessels entering and clearing at the port of Mobile, fiscal year 1881-1882.

Vessels.	Number.	Tonnage.	Cargoes.				Ballast.			
			Foreign.		Coastwise.		Foreign.		Coastwise.	
			In.	Out.	In.	Out.	In.	Out.	In.	Out.
Steamers	3	5,098	1	3	......	......	1	......	1	......
Ships	13	14,802	1	12	1	....	10	......	1	1
Barks	87	55,274	4	63	5	6	64	......	4	9
Brigs	23	6,127	4	10	7	13	3	......	9	......
Schooners	1,770	23,002	24	50	17	53	9	1	67	5
Total	1,896	104,303	34	138	30	72	87	1	82	15

Number and character of craft engaged in the harbor traffic.

	Number.	Tons.
Steamers, passenger	4	877
Sloops	17	75
Schooners	24	843
Tugs	12	1,181
Barges	31	2,394
Fishing-smacks	6	170

The following is a list of vessels drawing 13 feet and over that have arrived and departed from the wharves of Mobile, during the fiscal year ending June 30, 1882, without meeting with any difficulty; also the high and low-tide for the corresponding dates, as indicated by the tide-gauges, the average mean low-tide reading being 17 feet = 7.2 feet of former reports.

Date.		Name of vessel.	Character.	Draught.	Tide.	
					High.	Low.
1881.				*Feet.*		
July	2	Matilda	Ship	13	17.3	16.9
	8	Monarch	Bark	13½	18	16.4
	13	B. B. Church	Schooner	13	17.7	16.9
	15	Josephine	Bark	13	17.4	17
	20	Elliott Ritchie	...do	13	17.8	16.6
	20	A. Walker	Schooner	13	17.8	16.6
	21	J. Gadden	Bark	13	17.8	16.1

Date.		Name of vessel.	Character.	Draught.	Tide.	
					High.	Low.
1881.				Feet.		
July	21	Eliza	Bark	13	17.8	16.1
	26	Congelia	do	13	17.8	16.6
Aug.	24	Palos	Schooner	13	17.1	16.2
Sept.	4	H. Rogers	do	13½	18.3	16.8
	4	Benjamin Dickinson	Bark	13½	18.3	17
	8	Nannie T. Bell	do	13½	17.7	17
	19	G. W. Lochner	Schooner	13½	17.7	17.1
	27	James Miller	Brig	13½	17.7	16.9
Oct.	4	Jennie Cobb	Bark	13	17.8	17.2
	6	Lotus	do	13½	18.4	17.8
	28	Carrie Delap	do	13	18.1	17.2
	29	Augusta	do	13	18.1	17
Nov.	5	Decide	do	13	16.3	15.7
	11	David A. Preston	do	13	17.5	16.8
	12	Carrie Delap	do	13½	17.9	16.5
	18	J. D. Robinson	Schooner	13½	17.7	16.8
	18	Keystone	Brig	13½	17.7	16.8
	30	Wm. B. Wood	Schooner	13	17.4	16.8
Dec.	2	W. E. Clervis	Bark	13	17.1	15.6
	4	Havana	Brig	13	17	15.8
	14	Active	Bark	13	17.6	17.3
	14	J. D. Robinson	Schooner	13	17.6	17.3
	21	South Shore	do	13	16.8	16.8
	26	Alabama	Bark	13	18.3	17.2
1882.						
Jan.	2	Rebus	Bark	13	16.5	15.3
	4	Australia	do	13	16.9	15.9
	10	Alberese	do	13	17	16.6
Feb.	25	Navarino	Schooner	13	17	15.6
	25	Caroline	Bark	13	17	15.6
	25	Lena R. Stover	Schooner	13	17	15.6
	26	Assyria	Bark	13		
	28	Florence Rogers	Schooner	13	18.8	16.8
Mar.	2	Rillie T. Derby	do	13	16.7	16
	10	Statsroad Brock	Bark	13	17	16.3
	11	Friesland	do	13	17.6	15.8
	27	Howard	do	13	17.8	17
	27	Pepita	do	13	.7.8	17
Apr.	6	Harlequin	do	13½	17.8	17.7
	6	Friscia	do	13½	17.8	17.7
	6	Siberia	do	13½	17.8	17.7
	8	Countess Duchatelle	do	13	17.6	17.1
	8	James Miller	Brig	13½	17.6	17.1
	21	Siberia	Bark	13½	18.3	17.2
	22	Ermina	do	13	18.3	17.3
	25	Whiton	Schooner	13½	17.6	16.5
	25	Agate	Bark	13½	17.6	16.5
May	3	Julia	do	13	17.4	16.9
	4	Minnie Retz	do	13½	17.4	16.4
	9	Wm. Wright	do	14½	17.8	16
	15	Onkel Christian	do	13	17.4	16
	19	Wm. Wright	do	13	17.8	16.4
	26	Sadie Willett	Schooner	13	17.4	16.8
	27	Gerda	Bark	13	17.9	17.2
	28	Formosa	do	14	Sun day.	
June	2	Atlantic	do	14	18	16.8
	7	B. B. Church	Schooner	13	17.6	17
	9	Formosa	Bark	13	18	17.4
	12	Tinnie	do	13	17.7	16.4
	15	Savannah	do	14	18	16.5
	16	Flora	do	13	17.9	16.8
	24	Gerda	do	13½	17	16.7
	28	Joshua Lovering	do	13	17.5	16.7
	29	Juan C. Marga	do	13	17.6	16.2
	29	B. B. Church	Schooner	13	17.6	16.2

	Feet.
1881–1882:	
48 vessels; draught	13
19 vessels; draught	13½
3 vessels; draught	14
1 vessel; draught	14½
1879–1880:	
25 vessels; draught	13
4 vessels; draught	13½

K 2.

IMPROVEMENT OF PENSACOLA HARBOR, FLORIDA.

The improvement of this harbor was commenced November, 1878, by the removal of four wrecks near its entrance, forming obstructions to navigation and possibly being the partial cause of the formation of the shoal known as the "Inner Bar." The project was completed December 15, 1879.

A survey of the entrance to the harbor was made during the second quarter of 1879, for the purpose of ascertaining the extent and probable cause of the shoaling of the main ship-channel. This survey developed the existence of a bar stretching diagonally across the main channel, from the south end of the Middle Ground to the Caucus Shoal, varying from 1,000 to 3,000 feet in width between the 24-foot curves, and having a maximum depth on the crest on the line most eligible for the passage of vessels of 20.5 feet at mean low-water. With this exception the main channel was spacious and afforded a depth not less than 22½ feet at mean low-water, from the harbor to deep water of the Gulf.

The examination showed further that there was a movement progressing of the land and shoals, by encroachment from the east, and abrasions on the west lines at the entrance; the south and west shore line of Santa Rosa Island having within the past thirty years advanced from 300 to 400 feet, while a corresponding abrasion had occurred upon the opposite shore line at Fort McRae, and the water battery. This change in the water-way of the entrance had been accompanied with an expansion of the shoal known as the "Middle Ground" and its extension as described across the main channel. A report embracing the results of the survey was referred to the Board of Engineers and a project for the improvement of the harbor adopted, consisting of dredging a channel across the newly-formed bar, and the construction of jetties along the western shore line for the purpose of arresting the abrasion, preserving this shore line for defensive works, and restoring, as far as possible, the original regimen of the tidal currents, with its effect in keeping the channel open.

A contract was made July 28, 1881, for dredging the channel in accordance with the new project, but no work was performed by the contractor, and his contract was annulled. The work was readvertised May 26, 1882, bids opened June 26; Mr. Ed. H. Farquhar being the lowest bidder, at 40 cents per cubic yard, was awarded the contract. The construction of the first series of proposed jetties had also been submitted for proposals, but the bids for executing the work were considered excessive, and instructions were given to carry it on by hired labor and the purchase of materials in open market.

Preparations were commenced in September, 1881, for the collection of material, and the erection of buildings and construction of appliances required to prosecute the work was begun in October.

The progress made in this branch of the work during the fiscal year ending June 30, 1882, consists as follows:

Completion of quarters for overseer and workmen; mattress sheds 60 by 100 feet for preparing mattress work; tramways for delivering mattresses, ballast and brush; four tram cars for delivering and launching mattresses; two flushed decked scows 16 by 35 feet for transporting brush and working upon jetty; construction of shore end of jetty A, formed of crib-work filled with brush mattresses and rock ballast, extending 60 feet from mean low-water line; completion of piling for jetty

A and tramway 250 feet from mean low-water line and extension of tramway; completion of piling and partial completion of wharf at water extremity of tramway for receiving ballast for jetties.

The progress of the jetty work proper has been greatly impeded by the exceptionally stormy weather that has prevailed during the winter and spring and the exposed situation of the work.

An agreement was made with D. F. Sullivan for the delivery of rock ballast at the work for $1 per ton, under which 158.32 tons were supplied, when the delivery was discontinued on account of the danger and uncertainty of effecting an entrance into the lagoon with barges.

An agreement was made with W. H. Baker for the supply of brush suitable for the mattress work, at $1.25 per cord, to be delivered at accessible points along the lagoon. This agreement is being fulfilled, but it is apprehended that the want of rock ballast to carry on the work will necessitate a suspension of its delivery.

It is found by recent survey that the expansion and shoaling of the bar across the channel has been going on steadily since the survey of 1879, that the maximum depth of the crest has been diminished to 19.7 feet at mean low-water, and the area of the section between the 24-feet curves materially increased, augmenting the amount of dredging required to reduce the bar to 24 feet, about 75 per cent. over the amount estimated in 1879. As will be seen from the report heretofore made, the direction of the tidal currents is transversely to that of the proposed cut across the bar. To insure safety against the force of these currents, which at times is very powerful, as well as to preserve the channel from filling, the cut should be made as wide as possible. A width of 300 feet, which has been recommended for the present, will probably require the removal of about 80,000 cubic yards.

The results attained by the construction of jetty A so far accomplished are eminently satisfactory, and indicate the success of the plan adopted for the preservation of the shore line. The beach line, contiguous to the jetty in progress, has advanced from 25 to 50 feet, and the formation of a shoal has been effected along the shore, stretching from the water-battery in the direction of the beach to the northward of Fort McRae, reducing the depth 100 feet from the low-water line from 9 feet in January of the present year to 3 feet at mean low-water.

In time, it is obvious that the shoaling will advance with the construction of the jetties, until their influence in this respect is neutralized by the action of storm waves and tidal currents, and that there will be a proportionate decrease of the material required for their construction as the shoaling occurs in advance of the work.

It is a work, however, subject to great vicissitudes, rendered so not only by its exposed situation, but on account of the effect which the conformation of the shoals between it and the deep water of the Gulf and the tidal currents have in creating a sea, interrupting its progress and endangering its stability. It has therefore to be conducted under a close observation of its attendant results, and with caution and patience.

It is proposed that the funds available for expenditure during the fiscal year ending June 30, 1883, be applied as follows:

1st. To the removal as far as possible of the inner bar by dredging.

2d. To the completion of jetty A to the 15-foot curve, with wharf for the reception of ballast, and the commencement of two short shore protections as suggested by the Board of Engineers. Observation indicates that the restoration and preservation of this shore line can be most economically and safely effected by advancing the work simultaneously from several points along the line and extending each of the constructions or jetties exclusively with reference to its effect, and in no case is it thought advisable to extend a jetty as an isolated projection very much in advance of the restoration of the shore line which it effects, except upon a very easy slope.

The results that may be expected from this application of the available funds will be—

1st. The affording a channel-way, of a width proportionate to the amount applied, for vessels drawing 22½ feet at mean low-water, and 24 feet at mean high-water, into the harbor, now restricted to 21 feet under the most favorable conditions of tide and sea.

2d. The partial restoration and preservation of the shore line contiguous to Fort McRae within the influence of jetty A, and the proposed shore protections.

The sum of $50,000 can be profitably expended during the fiscal year ending June 30, 1884, in adding to the width and depth of the channel to be cut across the bar, and to the continuation of the jetty system as proposed by the Board of Engineers. The advantage to be attained by such expenditure will be additional safety and facility for the passage of vessels of deep draught in and out of the harbor, and the benefit to be derived by the preservation and restoration of the west shore line at Fort McRae, and such other points as observation may indicate to be essential in order to fulfill the objects contemplated in the project.

The estimated amount, exclusive of appropriations already made, for the completion of the work proposed, under the existing project, is $54,470.25.

For the purpose of repair of jetties and shore protections, and for the removal of accumulation likely to occur in the cut, an annual expenditure will probably be required, but the amount cannot now be closely estimated.

The work is situated in the collection district of Pensacola, Fla., which is the port of entry, and near Pensacola light-house and Fort Pickens and Barrancas.

Up to the 1st of June there had been entered during the fiscal year twelve ocean steamers, four hundred and seventy-four square rigged vessels, ninety-five sea-going schooners.

Many of the larger class of these vessels have been obliged to leave the harbor with partial cargoes, on account of a want of sufficient depth of water on the bar, and instances have been frequent when they have been detained for several weeks awaiting propitious conditions of tide to depart; and the safety of the ship and cargo endangered by grounding on the bar.

Money statement.

July 1, 1881, amount available	$69,611 47
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	17,752 13
July 1, 1882, amount available	51,859 34
Amount appropriated by act passed August 2, 1882	50,000 00
Amount available for fiscal year ending June 30, 1883	101,859 34
Amount (estimated) required for completion of existing project	54,470 25
Amount that can be profitably expended in fiscal year ending June 30, 1884	55,000 00

Abstract of bids received and opened July 9, 1881, dredging in Pensacola Harbor, Florida.

No.	Name of bidders.	Price per cubic yard.	Time of commencing work.	Time of completing work.
1	Samuel McDonald	$0 29	Three months after notification of award of contract.	One year after commencement of work.
2	Jas. E. Slaughter	72½	do	Do.
3	Geo. C. Fobes & Co.	69	do	Do.
4	S. N. Kimball	75	do	Do.
5	John Maguire	57$\frac{8}{10}$	do	Do.
6	G. L. Long	70	do	Do.

Abstract of bids received and opened June 26, 1882, dredging in Pensacola Harbor, Florida.

No.	Name of bidders.	Price per cubic yard.	Time of commencing work.	Time of completing work.
1	John Maguire	$0 69	According to specifications...	According to specifications.
2	G. L. Long	1 03	do	Do.
3	S. N. Kimball	85	do	Do.
4	Ed. H. Farquhar	40	do	Do.

STATEMENT OF CUSTOM-HOUSE RECEIPTS AND STATISTICS FOR THE FISCAL YEAR ENDING JUNE 30, 1882, PENSACOLA, FLORIDA.

Receipts.

Duties on imports	$102,833 84
Tonnage duties	53,233 65
Hospital tax	2,297 78
Official fees	4,332 11
Steamboat inspection	402 90
Fines, penalties, and forfeitures	1,291 08
	164,391 36
Value of imports	103,532 33
Value of exports	2,964,896 00

Entrances and clearances.

	Vessels.	Tonnage.
Entered:		
Foreign	416	275,682
Coastwise	223	118,407
American from foreign ports	36	13,310
Cleared:		
Foreign	472	325,661
American to foreign ports	54	21,025
American coastwise	161	60,451

Statement of timber and lumber exportations from Pensacola, Florida, for the fiscal year ending June 30, 1882.

Destination.	Vessels.	Tons.	Hewn.	Sawn.	Lumber.
			Cu. ft.	*Cu. ft.*	*Super. ft.*
Great Britain	262	215, 974	3, 110, 915	6, 860, 468	15, 099, 000
Europe	130	76, 625	1, 112, 238	1, 566, 280	11, 768, 000
West Indies, South America, &c	128	51, 674	7, 436	101, 065	33, 265, 000
Africa, Java, &c	5	2, 135	5, 092	19, 712	1, 048, 000
United States	132	57, 439	81, 042	....	39, 186, 000
Total	657	403, 847	4, 316, 723	8, 547, 525	106, 366, 000

K 3.

IMPROVEMENT OF CHATTAHOOCHEE RIVER, GEORGIA AND ALABAMA.

The work of improvement was commenced in the summer of 1874. The channel was badly obstructed with snags, sand-bars, and marl reefs, affording a low-water depth of from 1 to 4 feet and a width of from 35 to 500 feet. Between the shoals were deep pools needing no improvement, but the general availability for purposes of commerce was bad. The original project of improvement contemplated a low-water channel of 4 feet depth and 100 feet width, to be secured by removing snags and overhanging timber, blasting out the rock shoals, and deepening the sand-bars by scour, by the use of brush jetties, so constructed as to control the low-water flow solely.

No amendments or alterations have been since made.

The following tabulated statement shows the progress made during the fiscal year ending June 30, 1882:

Snags and overhanging trees removed	640
Linear feet of jetty built	1, 682
Linear feet of jetty repaired	77
Number of bars plowed	2
Linear feet of rock drilled	842
Number of blasts made	209
Average charge of powder ....lbs..	5
Number of cubic yards of rock removed	2, 614
Number of cords brush fascines made and transported to place	960

The condition of the improvement is shown by the following table:

Names of places.	Below Columbus, Ga.	Above Eufaula, Ala.	Below Eufaula, Ala.	Above Fort Gaines, Ga.	Original depth.	Present depth.	Original width.	Present width.	Remarks.
	Miles.	*Miles.*	*Miles.*	*Miles.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
Mound Bar	7	78	.....	......	1½	4	325	150	Brush jetties.
Abercrombie's Bar	8	77	......	......	1	4	350	150	Do.
Woolfolk's Bar	10	75	......	......	1⅓	4	500	150	Do.
Upatoie Bar	11	74	......	......	2	4	300	150	Do.
Little Uchee Shoal	17	68	......	......	2	4	50	60	Reef blasted.
Reef below Little Uchee	17½	67½	......	......	1½	4	50	60	Do.
Sleek Bluff	18	67	......	......	0	4	39	55	Do.
Middle Rocks	18½	66½	......	......	1⅓	4	30	100	Do.
Big Uchee	19	66	......	......	1½	4	35	65	Do.
Shell Creek Bar	24	61	......	......	3	3	350	350	Shore protection.
Culpepper Island	32	53	......	......	2	4	400	100	Jetties and blasting.
Hardridge's Shoal	......	......	27	6	2	4	35	100	Reef blasting.

Cody's Rock and Belton's Lower Rock have been partially removed and are now being worked on.

As far as the improvement has been completed, it is available for the purposes of navigation and commerce.

It is proposed to apply the funds available for expenditure, during the fiscal year ending June 30, 1883, in maintaining the completed works, in removing snags, and in blasting the following rock shoals: Cody's Rocks, Belton's Rocks, Uchee Shoals, and in contracting the channel, by brush jetties, between Bull Creek and Columbus, Ga. (a distance of 3 miles), with the expectation of securing a depth of 4 feet, where there is now not more than 2 feet at low-water. After this, if the funds available are sufficient, work will be commenced at Francis' Bar, 6 miles above Eufaula, Ala., and at King's Rock, 16 miles above the mouth of the river. One hundred thousand dollars can be profitably expended during the fiscal year ending June 30, 1884. It is proposed to use a portion of this amount, if appropriated, in procuring a new snag-boat, to replace the present one, which is nearly worn out; the balance to be spent in keeping the completed works in repair, in deepening the channel to 4 feet, wherever necessary, and in removing the annual accumulation of snags, thereby facilitating commerce by rendering navigation easier, and at all times practicable, when, without it, it might be impossible for boats to reach Columbus, Ga. (the head of navigation), in extreme low-water.

The amount, estimated, exclusive of former appropriations, required for the entire completion of the work is $150,000. The reason for this increased estimate is due to the formation of new bars and obstructions (not originally estimated for), caused by the large amount of sand precipitated into the river by reason of clearing and cultivating the land along its banks. The improvement will not be permanent when completed, and an expenditure of $10,000 annually is estimated as necessary for the preservation of the work, and for the removal of the annual accumulation of snags and other obstructions caused by the winter freshets.

The work is situated in the collection district of Savannah, Brunswick, and Saint Mary's, Ga.

Apalachicola, Fla., is the nearest port of entry.

CUSTOM-HOUSE STATISTICS FROM JUNE 30, 1881, TO MAY 27, 1882.

Receipts from all sources	$7,302 44
Number of vessels cleared	113
Tonnage of same	36,561
Value of exports (lumber)	$231,320 00

Commercial statistics for 1882 *and* 1874.

FOR THE YEAR 1882.

Steamers:		
Number		7
Tonnage		1,625
Draught	feet..	3-5
Value		$114,000

Articles.		Quantity.	Value.
Fertilizers	tons	5,960	$268,222
Iron	do	286	22,880
Cotton	bales	43,119	2,155,950
Grain	bushels	154,440	169,884
Lumber	feet	1,700,000	19,000
Merchandise	bales	3,025	226,875
Merchandise	barrels	604,800	4,233,600
Live stock	number	487	73,050
Passenger fare			30,800
Aggregate			7,314,261

FOR THE YEAR 1874.

Steamers:

Number		4
Tonnage		655
Draught	feet	3-5
Value		$82,000

Articles.		Quantity.	Value.
Fertilizers	tons	2,680	$120,600
Iron	do	243	19,640
Cotton	bales	25,800	1,290,000
Grain	bushels	91,400	100,540
Lumber	feet	465,000	5,680
Merchandise	bales	1,682	126,150
Merchandise	barrels	279,743	1,159,201
Live stock	number	254	38,100
Passenger fare			16,600
Aggregate			3,757,511

From the above statement it will be seen that the increase of commerce since the improvement was commenced, eight years ago, has been $3,556,750, or nearly double. It is believed that this ratio of increase will be maintained during the progress of the work, and will materially increase upon its completion. Deep water at Apalachicola, Fla., would add greatly to the commerce of this river, as a portion of the Northern and Western freights, which now go by railroad, would probably take the cheaper water-route.

Money statement.

July 1, 1881, amount available	$38,959 36
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	22,169 46
July 1, 1882, amount available	16,789 90
Amount appropriated by act passed August 2, 1882	25,000 00
Amount available for fiscal year ending June 30, 1883	41,789 90
Amount (estimated) required for completion of existing project	150 000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	100,000 00

K 4.

IMPROVEMENT OF FLINT RIVER, GEORGIA.

This improvement was commenced in November, 1877, below Bainbridge, Ga., and is virtually completed to Hell Gate, affording good low-water navigation from the mouth of the river to this point, a distance of 59 miles.

The original depth in the shoals, which were scattered all along the river, was from 6 inches to 3 feet, and the width of the channel varied from 30 to 300 feet. The obstructions consisted of loose bowlders in some places, and solid ledges in others, with deep pools intervening. The navigation was pretty good from the mouth of the river to Bainbridge, but it was impossible for the river steamers to travel above the latter place in low-water, and the navigation was exceedingly hazardous in high-water, in concequence of the large number of rocks.

The original project, which has been rigidly adhered to, contemplated opening a channel 100 feet wide and 3 feet deep at low-water. To accomplish this result, 22 rock shoals have been worked on. In March, 1881, the work of removing snags between Albany and Montezuma, Ga., was commenced with a snag-boat, worked by hand, and the work has been carried on with only slight interruptions from high-water to the present time. From Drayton to Montezuma (estimated distance 30 miles) the channel was so completely blocked up with snags as to render its navigation in a skiff difficult at extreme low-water.

The average width is about 70 feet, and the depth is sufficient for light-draught steamers when the obstructions are removed. Between Drayton and Albany there are twenty-four rock shoals needing improvement, but as this part of the river has not been surveyed, no positive data can be given. At present there is no transportation on the river above Albany, but there is material for a considerable commerce if transportation facilities were available.

PROGRESS MADE DURING THE FISCAL YEAR ENDING JUNE 30, 1882.

Below Albany, Ga.:	
Barges built	1
Linear feet rock drilled	3,024
Number of blasts made	600
Average charge, pounds powder	2
Cubic yards rock removed	2,627
Number of snags removed	59
Linear feet of stone dam built	350
Above Albany, Ga.:	
Number of snags removed	3,365
Overhanging trees cut	36

The condition of the improvement on the 30th June, 1882, between the mouth of the river and Hell Gate (59 miles above), is good for purposes of commerce and navigation, affording a low-water channel 100 wide and 3 feet deep. The results in the way of increased depth and width are exhibited in the following table:

Names of places.	Above Chattahochee.	Below Albany.	Original depth.	Present depth.	Original width.	Present width.
	Miles.	*Miles.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Lambert's Island	24	92	1	3	0	100
Rob's Rock	26	90	0	2	60	100
Broad Axe Rock	26½	89½	½	4	50	100
Bryant's Rock	31	85	½	4	70	100
Versaille's Rock	34	82	0	4	50	100
Bainbridge, Ga	36	80	1	4	100	100
Three Rock Reach	39	77	½	4	40	100
Below Cross Chute	40	76	½	4	30	100
Cross Chute	47	69	0	4	75	100
Fodder Stack Shoal	48	68	0	4	80	100
Reefs 1 to 10	48 to 57	68 to 59	1	3	40	100
Crawford's Point	57	59	0	4	70	100
Winding Shoals	58	58	1	3	40	100
Hell Gate	59	57	(*)	(*)	(*)	(*)

*Not completed.

It is proposed to apply the funds available for expenditure during fiscal year ending June 30, 1883, in continuing the improvement from Hell Gate towards Albany, Ga., and in removing snags between Drayton and Montezuma, Ga., according to the approved project.

The amount of $75,000 can be profitably expended during the fiscal year ending June 30, 1884. It is proposed to apply the funds, if appropriated, to pushing the improvement as commenced.

A large naval-store business is being developed as far above Bainbridge as the works have progressed, and is likely to keep pace with the improvement, as the river will afford the only outlet to the commerce thus developed. When Montezuma is reached, about one-half the distance between that place and Albany, Ga., will be available for commerce, where there is at present no public transportation.

It is believed that the original estimate of $175,000 will be sufficient to complete the improvement from Hell Gate to Albany, Ga., including the work yet to be done at Hell Gate. The improvement will be nearly permanent, and an annual expenditure of $2,000 for five years after its completion is deemed sufficient for its maintenance.

For the removal of snags between Albany and Montezuma, Ga., about $25,000 will be required to complete the work, and an annual expenditure of $5,000 will be necessary to maintain it for an indefinite time, as the river traverses a densely-timbered swamp, and fresh snags will be continually precipitated into the channel by the caving banks.

Any estimate for the removal of the rock shoals, in the absence of a survey, would be purely conjectural.

The work is situated in the collection district of Brunswick and Saint Mary's, Ga.

Apalachicola, Fla., is the nearest port of entry.

Custom-house statistics: Vessels cleared, 113; tonnage, 36,561; custom receipts, $7,302.44; value of exports (lumber), $231,320.

Money statement.

July 1, 1881, amount available	$21,974 84
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	19,177 63
July 1, 1882, amount available	2,797 21
Amount appropriated by act passed August 2, 1882	25,000 00
Amount available for fiscal year ending June 30, 1883	27,797 21
Amount (estimated) required for completion of existing project	127,829 52
Amount that can be profitably expended in fiscal year ending June 30, 1884	75,000 00

Commercial statistics for 1882 and 1877.

FOR THE YEAR 1882.

Steamers:		
Number		7
Value		$114,000
Tonnage		1,625
Draught	feet	3 to 5

Articles.		Quantity.	Value.
Fertilizers	tons	4,895	$220,275
Iron	tons	211	16,880
Cotton	bales	22,825	1,141,250
Grain	bushels	26,230	28,853
Lumber	feet	200,000	2,400
Timber	feet	17,600,000	176,000
Merchandise	bales	1,062	79,650
Merchandise	barrels	226,000	1,582,000
Live stock	number	45	6,750
Passengers' fare	value		5,200
Aggregate			3,373,258

FOR THE YEAR 1877.

Steamers:	
Number	4
Value	$82,000
Tonnage	655
Draught ... feet..	3 to 5

Articles.		Quantity.	Value.
Fertilizers	tons..	2,136	$96,120
Iron	tons..	185	14,800
Cotton	bales..	20,960	1,048,000
Grain	bushels..	23,160	25,476
Lumber	feet..	125,000	1,500
Timber	feet..	1,300,000	13,000
Merchandise	bales..	584	43,800
Merceandise	barrels..	165,400	1,157,800
Live stock	number..	42	6,300
Passengers' fare	value..	....	4,160
Aggregate		....	2,410,956

Showing a gain of $880,300 in the five years that the improvement has been in progress. It is believed, with the navigation opened through to Albany, that a large commerce will spring up, amounting in the aggregate to several times its present value.

Table of commercial statistics, approximate.

Names of towns on and near the river.	Value of merchandise sold, exclusive of cotton.	Bales of cotton sold.	Value of cotton sold.	Aggregate of all sold.	Bales of cotton made on the improvement.	Value of cotton made along the line of improvement.
Montezuma	$1,250 000	11,000	$550,000	$1,800,000	....	....
Oglethorpe	300,000	5,000	250,000	550,000	....	....
Americus	1,930,000	27,000	1,350,000	3,280,000	....	....
Albany	1,750,000	25,000	1,250,000	2,900,000	....	....
Newton	150,000	5,000	250,000	400,000	....	....
Camilla	627,600	8,000	400,000	1,027,600	....	....
Bainbridge	1,250,000	10,000	500,000	1,750,000	....	....
	7,257,600	91,000	4,550,000	11,707,600	*166,346	*$8,317,300

* From census report.

Aggregate value of real and personal property adjacent to the improvement, as per report of comptroller-general, 1881	$32,509,371
Estimated value of crops other than cotton	2,500,000
Value of cotton	8,317,300
Value of property and commerce interested	43,326,671
Merchandise sold	7,257,600
Total	50,583,971

K 5.

IMPROVEMENT OF APALACHICOLA RIVER, FLORIDA.

The improvement was commenced in December, 1874, the steam snagboat Clara Dunning being employed in removing logs and overhanging timber. The depth of water was sufficient, as well as the general width from bank to bank, but its availability for purposes of commerce was bad, in consequence of numerous snags. The old river at Virginia Bend, 50 miles above Apalachicola, was completely closed for a distance of 6 miles, and the only chance for navigation was through Moccasin Slough, which was very crooked and narrow, and badly obstructed with snags and overhanging timber; so much so that it required several days for a boat to work through.

The original project of improvement contemplated a channel 100 feet wide, and 6 feet deep at low-water, to be secured by removing snags and overhanging trees, as well as widening and straightening Moccasin Slough, and no change has been made in the original design.

In addition to the first project, Chipola Cut-Off has been opened to White's Bluff, on Chipola River, a distance of 9 miles.

During the fiscal year ending June 30, 1882, the entire river has been worked over, and the following obstructions removed: ninety-three snags, two rafts of drift, seventy-two overhanging trees, and 3,000 cubic yards of clay.

The condition of the river is good and available for the purposes of navigation and commerce. The canal at Moccasin Slough, which was the only place on the river with an inadequate depth and width, has been deepened 2 feet and widened 15 feet, giving a low-water depth of 4 feet and width of 85 feet.

It is proposed to apply the funds available for expenditure during the fiscal year ending June 30, 1883, in removing snags and such other obstructions as may find their way into the channel, with a view to maintaining the river in its present good navigable condition.

The amount of $15,000 can be profitably expended during the fiscal year ending June 30, 1884. It is proposed to share a portion of this amount with the Chattahoochee River in procuring a snag-boat for their joint use, to replace the Clara Dunning, now nearly unserviceable; the balance to be expended in working the boat, in removing snags, &c.

No estimate is submitted for the permanent completion of this river, as it is regarded as already accomplished, as far as practicable. Snags and overhanging timber will have to be removed every season to maintain the improvement, and an annual appropriation of $2,000 is considered necessary for an indefinite period.

The work is in the collection district of Apalachicola, Fla. Apalachicola, Fla., is the nearest port of entry.

CUSTOM-HOUSE STATISTICS FROM JUNE 30, 1881, TO MAY 27, 1882.

Receipts from all sources	$7,302 44
Vessels cleared	113
Tonnage of same	36,561
Value of exports (lumber)	$231,320

Money statement.

July 1, 1881, amount available	$4,239 58
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	2,109 74
July 1, 1882, amount available	2,129 84
Amount appropriated by act passed August 2, 1882	2,000 00
Amount available for fiscal year ending June 30, 1883	4,129 84
Amount (estimated) required for preservation of improvements annually	2,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	15,000 00

Commercial statistics for 1882 *and* 1874.

FOR THE YEAR 1882.

Steamers:		
Number		7
Value		$114,000
Tonnage		1,625
Draught	feet..	3–5

		Quantity.	Value.
Fertilizers	tons..	50	$2,250
Iron	tons..	145	11,600
Cotton	bales..	450	22,500
Grain	bushels..	14,040	15,444
Lumber	feet..	2,500,000	30,000
Timber	feet..	29,275,000	292,750
Merchandise	bales..	275	20,625
Merchandise	barrels..	28,800	201,600
Live stock	number..	90	13,500
Passengers' fare	value..	......	7,000
Aggregate			772,565

FOR THE YEAR 1874.

Steamers:		
Number		4
Value		$82,000
Tonnage		655
Draught	feet..	3–5

		Quantity.	Value.
Fertilizers	tons..	10	$450
Iron	tons..	65	5,200
Cotton	bales..	300	15,000
Grain	bushels..	5,280	5,808
Lumber	feet..	1,000,000	12,000
Timber	feet..	2,500,000	25,000
Merchandise	bales..	165	12,875
Merchandise	barrels..	2,265	15,755
Live stock	number..	25	3,750
Passengers' fare	value..	....	4,000
Aggregate		....	181,338

Showing a gain of $591,227 in the eight years during which the improvement has been going on.

There has been virtually no outlet at Apalachicola.

It is believed that the river commerce will increase very much when deep water is secured at the mouth of the river, as it is possible that freights from the North and West will take the water route, rather than the more expensive transportation by railroad.

K 6.

IMPROVEMENT OF APALACHICOLA BAY, FLORIDA.

The plan adopted for this improvement consists in dredging a channel through the bar at the mouth of Apalachicola River, 100 feet wide and 11 feet deep, at mean low-water, the original estimated cost being $100,000.

The bar begins half a mile from the town of Apalachicola, and extends to the lower anchorage, where there is from 11 to 13 feet of water, with only 4 to 4.5 feet on its crest; the commerce of the locality was necessarily carried on by lighters.

The first appropriation was in June, 1880, and the second in March, 1881; with the amounts thus available a cut was commenced in December, 1881, in 11 feet of water, in a direction south by west. For 5,748 feet it was continued and the depth of 11 feet obtained. One thousand nine hundred and sixty-seven feet of this was 60 feet wide; the rest of the 5,748 feet only 30 feet wide. The number of cubic yards excavated was 51,943. The outward terminus of the cut is in 7.5 feet of water, whence it deepens off to the anchorage.

The work done during the fiscal year increased the depth of the channel from 2.5 to 3 feet, greatly facilitating the loading of vessels, as the tow-boats no longer get aground.

It is proposed to apply the funds that may be available in 1883, first to completing the 30-foot cut way through the bar and then widening it as far as the amount will permit. This will admit to the wharf, at mean low-tide, vessels drawing 11 feet, which is the great result sought for. Forty-five thousand dollars can be profitably expended during the fiscal year ending June 30, 1884, which amount will complete the project.

The tendency of this bar is to lengthen, *i. e.*, to receive deposits on the outer end. Time alone can decide upon the permanent character of the work. It is probable that several appropriations of $5,000 each may be necessary at intervals of three or four years to preserve it.

Apalachicola is the collection district. Apalachicola is the port of entry.

Amount of revenue collected at the port of Apalachicola, Fla., during the fiscal year 1880, $292.50.

		Tons.
Steamers entered from foreign countries	22	3,592
Steamers cleared for foreign countries	10	4,269
Schooners entered from foreign countries	58	8,752
Schooners cleared for foreign countries	41	9,282

	Value.
Exported:	
153,137 railroad cross-ties	$53,737
482,000 feet sawn lumber	4,820
Other merchandise	7,084
Imported	11,570
Trade between domestic ports:	
Feet of lumber	7,409,000
Railroad cross-ties	54,000
Pieces cedar	5,707
Value of fish	$124,000
Value of oysters	42,000
Value of green turtle	1,600

Commerce in lumber and hewn timber is increasing rapidly and will continue to do so with increase of facilities at the port. The very beginning of this improvement, as an earnest that it will be done, is giving an impetus to commerce and real estate, which is evident, while there are no records to establish the fact. The unlimited amount of pine and cypress has attracted timber men from far and near, many of whom will avail of it as greater conveniences of shipment are offered.

Money statement.

July 1, 1881, amount available	$19,598 89
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	19,503 94
July 1, 1882, amount available	94 95
Amount appropriated by act passed August 2, 1882	25,000 00
Amount available for fiscal year ending June 30, 1883	25,094 95
Amount (estimated) required for completion of existing project	45,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	45,000 00

Abstract of bids received and opened, July 9, 1881, *for dredging in Apalachicola Bay, Florida.*

No.	Name of bidder.	Price per cubic yard.	Time of commencing work.	Time of completing work.
1	John Thomlinson	$0.29⅛	Three months after notification of award of contract.	One year after commencing work.
2	James E. Slaughter	44 9/16	do	Do.
3	George C. Fobes & Co	44½	do	Do.
4	S. N. Kimball	42	do	Do.
5	John Maguire	37 9/16	do	Do.
6	G. L. Long	44	do	Do.

K 7.

IMPROVEMENT OF TAMPA BAY, FLORIDA.

The object of this work is to facilitate navigation to the town of Tampa, the approach to which is a narrow and shallow channel through the upper bay, 5.5 feet being the depth at mean low-water.

In 1881, under an appropriation of $10,000, 18,530 cubic yards of material were excavated, deepening and partially straightening it for 2,900 feet in length, 9 feet deep and 60 feet wide.

During the present fiscal year, under an appropriation of $10,000, 30,709 cubic yards were dredged for a distance of 5,315 feet, giving under both appropriations 49,289 cubic yards of material removed; securing a cut 8,115 feet in length and 60 feet in width. Such is the condition of the improvement at the present time.

In dredging, rock was encountered at the mouth of the river 400 yards from the wharf; for this reason vessels using the port cannot avail of the bettered channel except in high-tides.

It is proposed to apply such funds as may be available during the fiscal year ending June 30, 1883, in widening the work already done and straightening the channel.

Should the work not be permanent, which time alone can decide, a small amount compared with the original cost, say $500, applied annually by appropriation and expended at intervals of four years, would prevent the cut from filling in.

This work is in the collection district of Key West, and Key West is the nearest port of entry.

In the deficiency of statistics, which have been asked for, it should be stated that five steamships extending commerce to Havana, Key West, Cedar Keys, New Orleans, and other places are owned in Tampa.

The tonnage of vessels entering port is 2,500.

Fifteen thousand cattle are annually shipped to Cuba, and the value of the commerce of the town to be benefited is about $500,000 annually.

Money statement.

July 1, 1881, amount available	$10,114 39
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	10,114 39
Amount appropriated by act passed August 2, 1882	20,000 00
Amount (estimated) required for completion of existing project	57,002 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	30,000 00

Abstract of bids received and opened, July 9, 1881, *for dredging in Tampa Bay, Florida.*

No.	Name of bidder.	Price per cubic yard.	Time of commencing work.	Time of completing work.
1	John Thomlinson	$0 29½	Three months after notification of award of contract.	One year after commencing work.
2	James E. Slaughter	45 8/10	......do	Do.
3	George C. Fobes & Co	44	......do	Do.
4	S. N. Kimball	39	......do	Do.
5	John Maguire	42½	......do	Do.
6	G. L. Long	33	......do	Do.

K 8.

IMPROVEMENT OF SUWANEE RIVER, FLORIDA.

There are several mouths to this river—the West Pass, but rarely used, and the East Pass. The first is more remote from Cedar Keys, the point of commerce for the river, and, presenting rock which must be removed to improve the channel, is a much more expensive undertaking than the second; and it being universally admitted that improving the channel through the bar at East Pass would result in the greater benefit, at less cost, it was decided to begin work here. The plan adopted was to dredge a channel through the East and West Passes, sufficiently deep and wide to accommodate the commerce of the locality, to remove snags and deepen shoals as high up as Roland's Bluff, and to give a depth of 4 feet water between there and Ellaville.

There are numerous shoals, some of them rocky and extensive, in this last part of the river, while below Roland's Bluff, to the mouth, it is a desirable watercourse for navigation, generally deep and few snags. The channel at the bar was originally very crooked, narrow, and shallow, 2 to 3 feet at low-water, and in time of continued northers bare.

The progress made during the fiscal year is straightening and deepening the channel to the extent of excavating 17,026 cubic yards of mud, sand, and shell, for a distance of 1,409 feet, width of 65 feet, and securing a depth of 6 feet at mean low-water.

It is proposed to apply funds that may be available in 1883, to a continuation of the dredging through the channel, according to the plan; when steamers and tow-boats will no longer be compelled to wait for high-tides to get into the river or out.

The sum of $20,000 can be profitably expended during the fiscal year 1884, in completing this channel to its proposed width, 100 feet, in cutting through a bar 300 feet across, and thus reaching a gap of 8 feet water through the outer reef, a proposed modification of the original project, which would render work in the West Pass unnecessary, and is fully worth the expense of a survey in view of economy. This bar is in the bay about a mile west of the west mouth of this channel, and thence, in the same direction, 1 mile to the gap; $42,158 is the estimated amount required for the entire improvement, unless storms should drive mud into the channel, in which case $4,000 or $5,000 in five or six years would probably maintain a condition of practicable usefulness.

This work is located in the collection district of Saint Marks, and Cedar Keys is the nearest port of entry.

The custom-house has been applied to for statistics, but none having been furnished, the following facts and approximations derived from observations and inquiries of the assistant engineer in charge are furnished:

STEAMBOATS PLYING THE SUWANEE.

In 1881:
Era, 60 tons, drawing 3 feet, towing logs, carrying passengers and freight.
Yulee, 50 tons, drawing 3 feet, towing logs, carrying passengers and freight.
In 1882:
Era, 60 tons, drawing 3 feet, with a barge for wood.
Yulee, 50 tons, drawing 3 feet, with a barge for wood.
Shafer, 60 tons, drawing 4 feet, with a barge for wood.
Eric, 40 tons, drawing 4 feet.

Rafts of saw-logs, pine, to the extent of 5,000,000 feet of lumber, board measure, and 220,000 cross-ties have been floated or towed down the river to Cedar Keys, where the logs have been converted into lumber, the ties shipped to Mexico. The quantity of cedar or of farm products or of general commerce could not be ascertained; an increase in all is evident from the greater animation in business and the largely increased freights.

The improvement must be completed, or near completion, before it can be ascertained what portion of this increase is due to it.

Money statement.

July 1, 1881, amount available	$7,685 74
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	7,481 73
July 1, 1882, amount available	204 01
Amount appropriated by act passed August 2, 1882	5,000 00
Amount available for fiscal year ending June 30, 1883	5,204 01
Amount (estimated) required for completion of existing project	42,158 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	20,000 00

Abstract of bids received and opened July 9, 1881, dredging at mouth of Suwanee River, Florida.

No.	Name of bidder.	Price per cubic yard.	Time of commencing work.	Time of completing work.
1	John Thomlinson	$0 33⅓	Three months after notification of award of contract.	One year after commencement of work.
2	James E. Slaughter	50	Three months after notification of award of contract.	One year after commencement of work.

K 9.

IMPROVEMENT OF CHOCTAWHATCHEE RIVER, ALABAMA AND FLORIDA.

Operations on the improvement of this river were first commenced, under an appropriation of $5,000, from the mouth of Mitchell's River, Florida, in November, 1874, and continued for a distance of 35 miles, until March, 1875.

Under a new appropriation of $5,000 work was resumed in May, 1875, continued until September, 1875, and 25 miles more of the river was improved.

Another appropriation of $5,000 having been made work was again resumed in May, 1877, and continued until August, 1877. A portion of the river previously improved was, owing to washing and caving in of banks, worked over again, and 30 miles more of the river were improved.

An unexpended appropriation of $5,000 being on hand, and $7,000 more having been appropriated, work was again resumed in January, 1880, and continued until April, 1881, and carried within 10 miles of Geneva, Ala. Part of the river previously improved was worked over again, the wrecks of the steamers Baton and Edwards were completely, and that of the steamer Eighth of January partly, removed, and 40 miles of the river improved.

In 1881 an appropriation of $10,000 was made for the improvement of Choctawhatchee River, Alabama and Florida, one half the amount to be expended in the improvement of the river from its mouth to Geneva, the other half to be expended in the improvement of the river from Geneva, Ala., toward Newton, Ala., making this part of the river, however, navigable for high-water only.

At the commencement of the work of improvement in 1874, the condition of the channel, from the mouth to Geneva, if a channel existed at all, was such as to be extremely dangerous for navigation even during high-water. In the lower half of the river, although there was an ample depth at low-water, it was so obstructed by snags, stumps, logs, and overhanging trees that boats were obliged almost in every instance to cut their way through. In the upper part of the river there was at a low stage of water an average depth of 2 feet, obstructed, however, by snags, sunken logs and trees, overhanging trees and wrecks, so as to be navigable only during high-water in the winter season, and merchants and farmers were obliged, and in fact preferred, to haul their produce and stores to and from the nearest railroad stations, generally a distance of from 50 to 80 miles, rather than take the risk of shipping by river.

Choctawhatchee River flows through Walton, Washington, and Holmes counties, Florida, and Geneva, Dale, and Barbour counties, Alabama, which, with their adjoining counties, are all rich cotton, wool, and sugar producing counties.

Before the war three steamboats of capacities from 1,500 to 2,000 bales of cotton, besides numerous other craft, navigated this river, and it was consequently kept in good navigable condition. During and since the war, up to 1875, this river, although a stream of considerable size and magnitude, draining a large and fertile portion of Alabama and Florida, and being susceptible of improvement so that 5 feet of water can be carried at all seasons of the year, having an average width of 350 feet, was greatly neglected as far as navigation was concerned.

A steamboat would make an occasional trip from Pensacola or Freeport to Geneva during high-water, but hardly ever attempted a second trip, the expenses for repairs amounting in almost every instance to more than the freight would bring.

The original project under which work was commenced was for removing obstructions in Choctawhatchee River, Alabama and Florida, from the mouth of Mitchell's River, Florida, to Geneva, Ala. In the appropriation of $10,000 for the fiscal year ending June 30, 1882, the original project was changed in so far as to expend one-half of the amount in the improvement of the river above Geneva, Ala., towards Newton, Ala., for high-water navigation only. In August, 1881, under an appropriation of $10,000, a log-boat 76 feet long, 17½ feet beam, with 3½ feet depth of hold, was constructed.

The necessary outfit and tools were purchased, and operations commenced at the mouth, called "Cypress Top." Cypress Top being the only mouth used now by boats, having 4½ feet of water at medium tide, work was commenced there on the 17th of August, and carried to the head of Cowford Cut-off, a distance of 40 miles. This work being completed on January 24, 1882; the log-boat was carried up the river to Geneva, Ala., and on February 8, 1882, work on the improvement of the river above Geneva, towards Newton, Ala., was commenced, and continued until May 31, 1882, when, the appropriation being nearly exhausted, operations were suspended; 25 miles of river above Geneva towards Newton were improved.

From August 17, 1881, to May 1882, there were removed, in both the upper and lower river, 872 snags, 1,068 stumps, 483 roots, 360 logs, 1,311 sunken trees, 6,075 overhanging trees, 6 large drifts of logs, trees, brush, &c., &c., 12 cubic yards of sand, and 330 yards of bank protected from washing by brush. The condition of this river from its mouth to the present head of navigation, a distance of 187½ miles, is such as to allow boats of 4½ feet draught of water to navigate at all times during a medium stage of the river.

At Harvesin's Whirl, Carter's Drive, Buzzard's Bar, near Pittman's Ferry, and at Parrott Creek, where, before the improvement, scarcely 2 feet could be carried over at low-water, 5 feet can safely be carried over now.

The channels through the Ninety-nine Islands, through the Boston and Cowford Cut-off, have also been improved so that boats drawing 5 feet of water can pass safely during low-water. As a result of the improvement to navigation and commerce, there were put on the river, even during the early stage of the work, in 1875, one steamboat, two sloops, and one barge, which, with the two barges and one sloop already running, were kept busy in supplying the increased demand for freights.

Several steamers from Pensacola and Freeport made occasional successful trips to Geneva, and business kept on steadily increasing.

The width of the river has not been materially changed or increased by the improvements (the average width being 350 feet) except at Harvesin's Whirl, Carter's Drive, and Buzzard's Bar, where, owing to the removal of drifts, saw-logs, sunken trees, and timber, which had lodged in the sand and narrowed the river down to scarcely 60 feet; it has since widened to nearly 400 feet, with 5 feet depth of water.

It is proposed during the next fiscal year to improve that part of the river between Geneva and Half Moon Bluff still farther (40 miles), so that boats can run even in the lowest stage of water during the summer months.

The part of the river between Scott's Slough and Half Moon Bluff, 45 miles, has been but slightly improved so far, and it is proposed to further improve that part also.

The improvements needed consist in the removal of snags, stumps, sunken logs, and trees, and overhanging trees, and the completion of the removal of the wreck of the steamer Eighth of January, situated about 6 miles above Half Moon Bluff.

It is proposed to continue the improvement of the river above Geneva towards Newton, Ala., for high-water navigation only, commencing at the point left off in May, 25 miles above Geneva, and extending it, if possible, as far as Claybank Creek, 20 miles, which point is within easy hauling distance of Newton, and will be entirely satisfactory to the merchants and planters of Newton and surrounding country for the present.

The results that may be expected from these improvements will be a clear channel of 5 feet draught of water with an average width of 150 feet from the mouth to Geneva, at all seasons of the year, and from Geneva to Claybank Creek, of a channel of the same depth, with an average width of 75 feet during a medium stage of the river.

The benefits to commerce that may be expected from these improvements are manifold.

It is expected that Geneva, Newton, Elba, Ozark, and numerous other towns along the Choctawhatchee and Pea rivers and Holmes Creek will be placed in daily connection with the railroad at Half Moon Bluff. Mail, express, and freight facilities will be improved; ready markets for cotton, wool, and other produce will be within easy reach; the production of staple articles will at least be doubled. Emigration, which for the want of traveling facilities had been kept away, will set in, and a naturally rich and fertile country will be greatly improved.

Within the last four years four saw-mills have been established along the river and its tributaries; a number of log and timber camps have been established, and by the further improvement of the river, so as to bring markets within easy reach, these industries will be greatly increased.

The amount that can be profitably expended during the fiscal year ending June 30, 1884—that is to say, from the mouth of the river to Newton, Ala.—is $30,000. Of this amount $5,000 should be expended in the improvement of the bar at the mouth called Cypress Top. Cypress Top has been exclusively used during the last three years by boats navigating this river, having a depth of 3 feet 9 inches at low-water, and 5 feet at high-water over the bar. The channel, however, shifts, and steamers drawing 4½ or 5 feet of water are frequently obliged to unload half of their cargoes or wait from one to four days before being able to cross the bar; $15,000 of the amount should be expended in the removal of trees from the banks, and in the closing of creeks, sloughs, and cut-offs from the mouth to Geneva, so as to confine all the water to one channel, which by increasing the currents would have a tendency towards scouring and deepening the main channel; $10,000 of the amount should be expended in continuing the improvement of the river above Geneva towards Newton, Ala., so as to secure navigation to that point during a medium stage of the river.

The advantages and benefits that may be expected from the expenditure of these amounts and for the purposes stated are the opening of the river between Geneva and Newton to navigation, thereby securing to those living on or near that section of the river a great saving in freights and greater convenience and safety to the rapidly increasing commerce on that portion of the river below Geneva, already partially improved. This river is not susceptible of a permanent and complete improvement, owing to the continual washing of the banks causing trees to fall. The estimated amount required to maintain this river in the condition contemplated by the plan of improvement is $2,000 per year.

Choctawhatchee River is located in the collection district of Pensacola, Fla. Pensacola, Fla., is the nearest port of entry. Choctawhatchee River empties into Choctawhatchee Bay and through Santa Rosa Sound into Pensacola Bay and the Gulf of Mexico.

Pensacola light-house, Pensacola navy-yard, Forts Pickens, Barrancas and McRae are situated near the entrance to Pensacola Harbor.

COMMERCIAL STATISTICS.

The aggregate amount of staple articles transported on this river during the fiscal year ending June 30, 1882, are as follows, as compared with 1874.

Articles.		1882.	1874.
Cotton	bales	4,200	350
Wool	lbs	22,000	1,500
Sirup	bbls	400	70
Sweet potatoes	bush	2,500	1,000
Pea-nuts, peas, &c	bush	600	150
Fowls	doz	800	200
Honey	galls	500	60
Eggs	doz	2,400	500
Cattle	no	130	....
Gophers	no	600	100
Firewood	cords	300	....
Sugar	bbls	110	....
Hewn timber	cubic feet	450,000	160,000
Sawn timber	cubic feet	500,000	....
Saw-logs	no	280,000	35,000
Lumber	feet	75,000	....
Grain	bush	38,000	2,000
Guano	tons	1,100	....
Salt	sacks	1,900	350
Iron	tons	1,600	....
Hay	bales	270	....
Machinery	tons	250	....
Merchandise	tons	3,000	400

The character, number, tonnage, draught of water, &c., of the vessels or craft employed on the river during the fiscal year ending June 30, 1882, were as follows:

Name of vessel.	Character.	Length.	Tonnage.	Draught of water.
		Feet.		*Feet.*
Peerless	Steamer	190	276	5
Big Sunflower	do	165	210	4½
Alice	do	133	150	4½
Lulu Burns	do	31	5	3½
Dora	Schooner, sail	......	20	3½
South Ann	do	......	15	3½
Adelaide	do	......	15	3
Alex. Cooke	do	......	22	3½
Sarah	Sloop, sail	......	17	3½
Rhoda	do	......	13	3½
Ed. Woodwold	Barge, poling	85	28	3½
A. D. McKinnon	do	75	20	3½
Flat	Flat	50	7	2
Do	do	45	6	2
Do	do	30	4	1½
Alabama	do	79	40	4
Florida	do	80	40	4
Dora	Sloop	28	8	2½
Flying Cloud	do	27	6	3
Star	do	36	11	3

Vessels employed in transportation during the year preceding commencement of improvement, 1874.

Name of vessel.	Character.	Length.	Tonnage.	Draught of water.
		Feet.		*Feet.*
Rhoda	Sloop, sail	....	13	3½
Greyhound	Barge, poling	75	20	3
Hinson	do	80	22	3

The probable increase in the commerce by completion of the contemplated improvement may safely be estimated at 100 per cent.

Merchants and farmers were obliged to haul their produce and supplies to and from the railroad station before steamers were put on the river.

At that time the total cost of hauling and shipping one bale of cotton from Geneva to New Orleans was $4.50.

To-day the expense of shipping one bale of cotton from Geneva to New Orleans down the river per steamer is $1.50—a considerable reduction in freight.

Money statement.

July 1, 1881, amount available	$9,632 67
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	9,203 74
July 1, 1882, amount available	428 93
Amount appropriated by act passed August 2, 1882	20,000 00
Amount available for fiscal year ending June 30, 1883	20,428 93
Amount (estimated) required for completion of existing project	66,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	30,000 00

K 10.

IMPROVEMENT OF WITHLACOOCHEE RIVER, FLORIDA.

An examination of this river, authorized by act of Congress approved March 3, 1879, was made from Hayes's Ferry to its mouth during September, 1879, and the report submitted March 6, 1880, is contained in Annual Report of Chief of Engineers for 1880.

The project adopted is to improve the river by the removal of snags, overhanging trees, and loose rocks, and the deepening of some of the worst shoals and a bar near the mouth of the river, so as to enable boats drawing 2 feet of water to navigate the river during about half of the year.

The present depth of the river varies from 1 to 7½ feet, with a width of from 50 to 160 feet, and the estimated cost of the improvement is $23,900.

Under the appropriation of $7,500 made for this work by act of Congress approved March 3, 1881, a suitable snag-boat was built and equipped during the winter of 1881–'82. On the 1st March work was commenced on the river near its mouth, and continued until the latter part of May, when, owing to the great difficulty of obtaining labor, operations were suspended and not resumed during the fiscal year.

The following is the summary of work done during the fiscal year ending June 30, 1882:

4 miles of river worked over.
1 snag-boat built and equipped.
648 snags pulled.
99 overhanging trees removed.
200 cubic yards of rock removed.

The improvement was not sufficiently advanced during this fiscal year to materially change the condition of the river; no results, therefore, in the way of increased width or depth have been obtained, nor have any advantages to commerce accrued.

With the unexpended balance on hand, and the amount that may be appropriated for fiscal year ending June 30, 1883, it is proposed to clear the river of snags, overhanging trees, and loose rocks, as far as the joint amounts will permit.

The amount which can be profitably expended during the fiscal year ending June 30, 1884, is $16,400, which, with whatever balance may be on hand, will, it is expected, complete the improvement as projected.

The advantages and benefits to be derived from the improvement of this river are as yet conjectural, but the large influx of population from other States into the country along the line of the river justifies the expectation that they will be considerable.

The amount asked for, $16,400, will be required for the completion of the improvement, which will not be permanent, but will require a small annual appropriation.

This work is in the collection district of Key West, Fla., and Key West is the nearest port of entry.

No commercial statistics are reported; large quantities of oranges, however, estimated enough to keep one steamer fully employed in their transportation during the fruit season, seek a market by this route, and many rafts of pine and palmetto timber are floated down the river.

Money statement.

July 1, 1881, amount available	$7,500 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	3,568 37
July 1, 1882, amount available	3,931 63
Amount (estimated) required for completion of existing project	16,400 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	16,400 00

K 11.

IMPROVEMENT OF PEAS CREEK, FLORIDA.

An examination of this creek, authorized by act of Congress approved March 3, 1879, was made from its mouth to Fort Meade in October and November, 1879.

The principal work found necessary is between Fort Meade and McClelland's Ford, and consists in the removal of overhanging trees, snags, and loose rocks.

An appropriation for this improvement of $7,000 was made by act of Congress approved March 3, 1881. This appropriation not being sufficient to admit of both building and equipping a suitable log boat and leave enough of the appropriation to work to advantage, authority was asked and obtained to build one in conjunction with the improvement of the Withlacoochee River, which was done, and the boat put to work on the Withlacoochee.

As it was deemed best to commence the improvement of the Withlacoochee River first, work was deferred on Peas Creek until the exhaustion of the appropriation of that river.

No work was done on Peas Creek during the fiscal year ending June 30, 1882, consequently no changes in its condition or commerce have occurred.

It is proposed to apply the amount available during the fiscal year ending June 30, 1883, to improving the creek according to the adopted project.

Five thousand and seven hundred dollars can be profitably expended during the fiscal year ending June 30, 1884, which, if appropriated, will be used in continuing the improvement by removal of snags, overhanging trees, and loose rocks, thereby placing the river in navigable condition.

The amount, exclusive of former appropriations, required for the completion of this work is $5,700, which will not be permanent, but will require a small annual appropriation.

No statistics are obtainable. The principal trade is in cattle and oranges.

The work is in the collection district of Key West, Fla., and Key West is the nearest port of entry.

Money statement.

July 1, 1881, amount available	$7,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	2,423 33
July 1, 1882, amount available	4,576 67
Amount appropriated by act passed August 2, 1882	4,000 00
Amount available for fiscal year ending June 30, 1883	8,576 67
Amount (estimated) required for completion of existing project	5,700 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	5,700 00

K 12.

IMPROVEMENT OF ESCAMBIA RIVER, FLORIDA AND ALABAMA.

An examination and partial survey of this river was made in 1878–'79, from the Alabama and Florida State line to its mouth.

The river was ascertained to be from 150 to 300 feet in width and with ample depth for steamboat navigation.

The obstructions consisted of a bar at its mouth, and snags and overhanging timber along its course.

The plan of improvement adopted was to dredge a channel through the bar at the mouth 150 feet wide and 5½ feet deep at mean low-water, the construction of wing-dams and shore protections for conserving the water to the channel, and removing the snags and overhanging timber.

The progress of the work during the fiscal year ending June 30, 1882, consisted in the dredging of a channel through the bar 100 feet wide, affording a depth of 5½ feet at mean low-water; the entire length of the cut being 3,240 feet.

No perceptible shoaling has occurred in the cut since the completion. Its adaptability to the navigation of the river and facility for the towage of lumber rafts, previously dependent upon the tides for movement from Ferry Pass to the head of the bay, constitute its chief advantage.

It is proposed that the funds available for expenditure for the fiscal year ending June 30, 1883, be applied to the construction and employment of a log boat and appliances for removing snags and overhanging timber, and to the construction of dams and shore protections for conserving the water to the channel.

The results that may be expected from such application will be the maintenance of the dredged cut through the bar, and an improved condition of the channel in the river above by the removal of obstructions.

The amount that can be profitably expended during the fiscal year ending June 30, 1884, will be $6,000, to be applied to the rectification of the channel, removal of overhanging trees and snags, and in constructing shore protections, with the consequent advantages to navigation.

The estimated amount, exclusive of appropriations already made, required for the completion of the improvement is $6,000, after which it will require an annual appropriation of $3,000 to keep it clear of obstructions, and maintain it in the condition contemplated in the plan of improvement.

The work is located in the collection district of Pensacola, Fla., with Pensacola as the port of entry, and in the vicinity of Fort Pickens and Pensacola Light-house.

The commerce of the river consists chiefly of hewn and sawn timber and lumber; about 10,000,000 cubic feet of timber having been transported down the river during the fiscal year ending June 30, 1882. The transportation of merchandise, cotton, sirup, and other farm products have but recently been commenced and the amount is yet meager. The improvement of the river in adding facilities to such means of transportation is confidently thought will go largely to augment this branch of its commerce.

Money statement.

July 1, 1881, amount available	$12,671 31
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	9,310 88
July 1, 1882, amount available	3,360 43
For Escambia and Conecuh:	
Amount appropriated by act passed August 2, 1882	12,000 00
Amount available for fiscal year ending June 30, 1883	15,360 43
Amount (estimated) required for completion of existing project for the improvement of the Escambia	6,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	6,000 00

Abstract of bids received and opened July 9, 1881, *dredging in Escambia River, Florida.*

No.	Name of bidder.	Price per cubic yard.	Time of commencing work.	Time of completing work.
1	John Thomlinson	$0 33⅓	Three months after notification of award of contract.	One year after commencement of work.
2	John Maguire	45	Three months after notification of award of contract.	One year after commencement of work.

K 13.

IMPROVEMENT OF ALABAMA RIVER, ALABAMA.

The examination and partial survey of this river was made during the months of July to October, 1875, as provided for by act of Congress approved March 3, 1875. The report was made during the month of March, 1876, and is contained in the Annual Report of the Chief of Engineers, U. S. A., for 1876.

The original condition of the river channel during the low-water season was such that commerce was much restricted, the smallest class of steamboats only running. These restrictions were caused by the innumerable bars, shoals, reefs, and collection of sunken logs and snags, at many of which points the low-water depth was reduced to 3½ feet, and at some points to 2½ feet. The width of the channel varies with the width of the river.

The general width of the river from the mouth of the Tallapoosa River down to Gainstown ranges from 500 to 600 feet; below that point the width increases to 700 and 800 feet; wherever these widths are exceeded to any extent are found the bars, shoals, and reefs. In the open reaches of the river ample water is found.

The project adopted was designed to obtain a channel depth of 4 feet at low-water, with a minimum width of 200 feet from the mouth of the river 50 miles above Mobile, Ala., to the city of Wetumpka, Ala. The estimated cost was $229,741.

The appropriations for the work are as follows:

By act of Congress approved June 18, 1878	$25,000
By act of Congress approved March 3, 1879	30,000
By act of Congress approved June 14, 1880	25,000
By act of Congress approved March 3, 1881	20,000
Total	100,000

Work was commenced on the improvement during the low-water season of 1878, and prosecuted through the fiscal years ending June 30, 1879, 1880, and 1881.

During the present fiscal year the break in the dam at the head of the "Cut-off," 20 miles above the mouth of the river, was successfully closed, and the brush jetties on the opposite side of the river, closing the island chute, were partially rebuilt and repaired. A marked increase in the depth of water across the shoal below the works at the "Cut-off" was found shortly after the work was completed, and when the river had reached its lowest stage the channel through the shoal had improved to such an extent that it offered no further obstruction to navigation.

The right-hand chute at Yellow Jacket Bar was closed by completing the rock dam left unfinished during a previous year. A breach about 250 feet in width with a depth of 8 feet of water, was found in the rock dam at Hobbs' Island, built to close the left-hand chute; a new site was selected further down the chute, and an entire new dam was constructed and the chute again closed.

The dam across the left-hand chute at Gardner's Island was completed during the previous year; but owing to the formation of a large sand bar in the main river just below the mouth of Big Mulberry Creek, which bar almost entirely closed the river to navigation, the entire force was ordered from the lower river to this point, and a passage-way for boats cut through the dam. This afforded immediate relief, and no further trouble was met with during the remainder of the low-water season.

The entire river from Selma down to the "Cut-off" was worked over, the channel cleared of all dangerous logs and snags, and the chutes and close places cleared of all overhanging timber.

The following is a summary of the work done during the fiscal year ending June 30, 1882:

Miles from Mobile.	Name of place.	Brush jetties built.	Clay put in cribs.	Rock placed in dams.	Cribs sunk.	Piles driven.	Rock dam built.	Gravel put on dams.	Snags and logs removed.	Overhanging trees cut.	Depth before improvement.	Depth after improvement.
		L. ft.	*C. yds.*	*Tons.*			*L. ft.*	*C. yds.*			*Feet.*	*Feet.*
70	"Cut-off"	130	300	105	11	35	220				3	5.5
108	Williamson's Bar								26	32		
122	Jewett's Bar								161		4	6.5
125	Shackelford's Bar								3			
126	Flynn's Bar								55			
154	Silver Creek Bar								86	460		
158	Stabler's Bar								7			
165½	Cobb's Landing									49		
166	Hanie's Island								109	328		
170	Bates' Bar								73			
180	Stern's Island								17	224		
184	Ohio Bar								4	101		
185	Montgomery Bar								35	82		
187	Wilcox Bar								8			
189	Tait's Bar								22	94		
191	Black's Bluff Bar								35	61		
192	McNeil's Bar									7		
203	Hobbs' Island			355			180	675		49		
204	Yellow Jacket Bar			225			186	375			3.5	4.5
206	Harris Evans' Bar									38		
208½	Bar above Walnut Bluff									143		
209	Evans' Upper Bar								73	54		
224½	Miller's Ferry								1			
225	Prairie Bluff								1			
227	Hobbs' Shoal								12			
228	McGuire's Landing								15			
229	Chute below Mixon's									51		
253	Saint John's Bar								12			
261	Lexington Bar								3			
265	Young's Landing								19			
268	Portland Upper Bar								130			
273½	Lower Sister Bar									168		
274½	Middle Sister Bar								27	34		
275	Upper Sister Bar									171		
280	White's Bar								24			
281	Wilcox Bar								7			
282	Mary Taylor's Bar								21	107		
282½	Mitchell's Bar								26			
292	Wats Chute									11		
301	Cade's Bend Bar								15			
303	Tight Eye									76		
304	Valley Creek Bar								12			
325	Gardiner's Island					3			26	110	2.5	4.5
	Total	130	300	685	11	38	586	1,050	1,065	2,150		

The following table shows the character and extent of work executed during previous years:

Miles from Mobile.	Name of place.	Brush dams.	Rock dams.	Mattresses laid.	Mattresses laid.	Shore end of dam built.	Snags and logs removed.	Piles driven.	Original depth.	Present depth.
		L. ft.	L. ft.		C. yds.	Feet.			Feet.	Feet.
	Below "Cut-off"						5			
70	"Cut-off"	1,740					1	137	2.5	5.5
	Cut-off to Erwin's						344			
	Erwin's to Hanie's Island						130			
166	Hanie's Island	2,482							2.5	4
	Hanie's Island to Hobbs'						133			
203	Hobb's Island		435						3	4
204	Jellow Jacket Bar		400						2.5	4.5
	Yellow Jacket to Kaiser's						198			
325	Gardner's Island			81	1,460	200	491	600	2	4.5
376	Cox's Bar		690				274	616	2.5	4
374	Hadnot's Bar		600				416		2	3.5
385	Three Chutes		350				152		2	4

The river from Montgomery to its mouth, during the low-water season, is available for all purposes of navigation and commerce, as carried on during that season; the work undertaken and accomplished between those points affording the required relief. Boats are enabled to run by day or night without any serious delay if handled by skillful pilots. Above Montgomery navigation on the river is virtually closed during the low-water season, as no work of any kind has yet been undertaken on that portion of the river.

It is proposed to apply the funds available for expenditure during the next fiscal year to improving the bars, shoals, and reefs that exist on that part of the river between Selma and Wetumpka, the head of navigation, and to perfect the works of improvement already established on the lower portion of the river.

The sum of $25,000 can be profitably expended during the fiscal year ending June 30, 1884, in continuing and perfecting the work of improvement, according to the project adopted.

The work is not susceptible of permanent improvement, owing to the immense freshets which annually occur. These freshets constantly change the channel-ways, in some instances to a great extent.

An annual appropriation of at least $10,000 will be necessary to maintain the river in the condition contemplated by the plan of improvement.

The work is situated in the collection district of the port of Mobile, Ala., and commences 50 miles above that port of entry.

Money statement.

July 1, 1881, amount available	$41,854 20
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	35,755 73
July 1, 1882, amount available	6,098 47
Amount appropriated by act passed August 2, 1882	20,000 00
Amount available for fiscal year ending June 30, 1883	26,098 47
Amount (estimated) required for completion of existing project	109,741 00
Amount that can be profitably expended in fiscal year ending June 30, 1881.	25,000 00

COMMERCIAL STATISTICS.

The following table will show the amount of commerce using the river during the fiscal year ending June 30, 1882:

Articles.		From Mobile to Selma and Montgomery and points between.	From Montgomery and Selma to Mobile and points between.	Totals.	Valuation.	Amount.
Bacon	boxes	15,404		15,404	$40 00	$616,160 00
Corn	sacks	73,356		73,356	3 00	220,068 00
Oats	sacks	31,248		31,248	3 50	109,368 00
Hay	bales		6,003	6,003	3 00	18,009 00
Coffee	sacks	7,460		7,460	17 50	130,550 00
Bagging	rolls	20,317	2,400	22,717	6 00	136,302 00
Ties	bundles	37,645	3,500	41,145	1 75	72,008 75
Staves	pieces		204,000	204,000	*100 00	20,400 00
Wool	bags		2,740	2,740	60 00	164,400 00
Hides	pieces		4,657	4,657	3 00	13,971 00
Lumber	feet	533,000		533,000	10 00	5,330 00
Shingles	M	1,640,000		1,640,000	2 00	3,280 00
Stock	head	1,216	2,174	3,390	20 00	67,800 00
Furniture	packages	7,440	1,460	8,900	10 00	89,000 00
Cotton seed	bags		47,857	47,857	60	28,714 20
Cotton	bales	5,823	32,000	37,823	55 00	2,080,265 00
Barrels, assorted	barrels	80,745	4,680	85,425	7 00	597,975 00
Iron	tons	2,258		2,258	30 00	67,740 00
Miscellaneous	packages	22,405	5,060	27,465	5 00	137,325 00
Machinery	pieces	2,389	640	3,029	25 00	75,725 00
Agricultural implements	packages	5,840	1,250	7,090	5 00	35,450 00
Total						4,689,835 95

* Per thousand.

Valuation of boats employed	$80,000 00
Tonnage of boats employed ... tons	1,151.35

K 14.

IMPROVEMENT OF WARRIOR AND TOMBIGBEE RIVERS, ALABAMA AND MISSISSIPPI.

I.—BLACK WARRIOR RIVER.

The survey of this river from Locust Fork to the mouth, authorized by act of June 23, 1874, was made in the following autumn, and the report submitted January 27, 1875.

The project adopted for the improvement of this river was to secure a channel 4 feet deep and 30 feet wide from the mouth to Tuscaloosa, by the removal of logs, overhanging trees and wrecks, and by deepening the bars—the estimated cost being $151,103.

Work was commenced in July, 1875, and has continued under the following appropriations:

By act of March 3, 1875, for the Black Warrior and Tombigbee below Columbus	$25,000 00
By act of August 14, 1876, for Warrior and Tombigbee	15,000 00
By act of June 18, 1878, $40,000, of which for Warrior and Tombigbee below Columbus	28,000 00
By act of March 3, 1879, $30,000, of which for Warrior and Tombigbee below Columbus	20,000 00
By act of June 14, 1880, $47,000, of which for Warrior	20,000 00
By act of March 3, 1881, $25,000, 20-47 of which was for Warrior	10,638 38

Of the above joint and special appropriations there have been available for the Warrior $75,638.38. Before the improvement was commenced, the Warrior was navigable during the winter and spring only for a period varying from four to seven months; the trees thrown into the river by land-slides and other causes had in the course of years so choked the bed of the stream that on a less stage than four feet above low-water, navigation was seldom attempted; three boats were sunk in making the effort within five years previous to commencing the improvement.

At low-water there were ninety-six bars and shoals that afforded only 18 to 30 inches depth, and at all stages the overhanging timber, owing to the moderate width of the river, added to the risk and difficulty of navigation.

1875–1876.

The work was commenced at Tuscaloosa, Ala., and carried on down stream until suspended on account of high water, November 26, and not resumed until June 5. Twenty bars were improved.

Time spent on the improvement, months	5
Length of dams and jetties built, feet	5,761
Number of logs removed	417

1876–1877.

Work continued from July 1 to August 10, when it was suspended on account of the exhaustion of the appropriation. It was resumed November 1, suspended for the winter December 31, and resumed again May 1.

Time occupied on the work during the year was, months	5⅓
Number of additional bars improved	10
Length of dams and jetties built, feet	5,076
Number of logs removed	798
Number of trees felled	1,052

1877–1878.

No appropriations were made for the work this year, and the balance of funds on hand was expended by the log-boat on the lower half of the river. The work was carried on for four and one-quarter months, and suspended November 7.

The season proved wet and unfavorable. Frequent swells in the river occurred, and low-water was not reached during the year.

The number of logs removed was	804
The number of overhanging trees cut	73

1878–1879.

Work commenced July 3 and continued until September 10, when the force was transferred to the Tombigbee River. Repairs and extensions of former work on four bars were made and three others improved.

Time occupied on the work, months	2¼
Length of dams and jetties built, feet	2,190
Logs removed	713

1879–1880.

No work was done on the Warrior this fiscal year, its proportion of the joint appropriations heretofore made for the Warrior and Tombigbee rivers having been exhausted.

1880–1881.

A special appropriation having been made for the Warrior this year, a log-boat and barge were built in Mobile and towed up to the mouth of the river. Here they were joined by a quarter-boat and scow from the Tombigbee, and on October 15 commenced work 30 miles above. On November 20 high-water caused suspension of operations. During the winter the log-boat was up to Steele's Bluff, 75 miles, to remove obstructions caused by a number of trees brought into the river near that place by an extraordinary local flood on some neighboring creeks.

The log-boat commenced work on them in February on a 35-foot stage of water, and by removing them as the water fell prevented any interruption to navigation. On May 23, work on the lower portion of the river was resumed with a full force.

The working time during this year amounted to, months	5
Length of dams and jetties built, feet	1,821
Logs removed	369
Trees cut	3,081

One steamboat wreck taken out.

PROGRESS OF WORK DURING FISCAL YEAR ENDING JUNE 30, 1882

The force employed July 1 on the lower portion of the river continued work until November 30, at which date the boats were tied up for the winter at Lake Bend. Improvements were made on fifteen bars extending from the mouth of the river to Millwood, 43 miles from Demopolis. The Warrior (log-boat) also worked over this portion of the river, removing all logs that could be found, and as the water was very low a good opportunity for thorough work was afforded. During August the equipment for this river was increased by a barge and quarter boat built at Tuscaloosa, and on September 5 a party commenced work at Tressel's Bar, 39 miles below.

This bar had been improved in 1875, but some of the work had been damaged by steamboats and its efficiency injured.

Repairs and amendments were also found needed and were made at Cunningham's, McCown's, and Meed Bars. On account of high-water on November 2 work was suspended and the boats taken to Lake Bend and tied up with the other boats. During the winter, a cut-off that had been forming for years occurred above Williford's, 50 miles below Tuscaloosa, and many trees were thrown into the river by the caving bank below. To prevent interruption to navigation, the log-boat Warrior was towed up to this place in the latter part of March, and commenced dragging for the trees (which made perceptible breaks), with the river at 36 feet above low-water. They were taken out, as the water fell, to the number of 147, and steamboats met with no interruption or delay. A levee 550 feet long and 1 to 6 feet high was thrown across a depression in the bank below and opposite the mouth of the cut-off, that led through a lake into the river below. This was done to stop the deepening of this depression, which had already commenced at high-water and threatened to form another cut-off.

On the 15th of May the boats at Lake Bend were moved up to Jeannings' Ferry, 45 miles above, and the improvement there commenced. A summary of the year's work is—

Time occupied on the work, months	8
Length of dams and jetties built, feet	10,111
Logs removed	1,689
Trees cut	2,919

The unusual drought of last summer caused a lower stage of water by 10 to 12 inches than any observed since the survey was made in 1874. In the tabular statement below, showing the present condition of the improvement, the depths heretofore given have been reduced to conform to the low water stage of last summer.

Examinations of work done have been seldom made, because they are useful only at low-water, and such periods have been seldom available for want of time and of facilities for passing over the river.

Soundings made, except at lowwater, are of little value, because, on the shoals, the river bed rises and falls to some extent with the water surface.

Name of bar.	When improved.	Linear feet of dams and jetties.	Original depth.	After improvement.		Remarks.
				Width.	Depth.	
			Feet.		*Feet.*	
Eagle Shoals	1875	318	2	50	3½	Observed September, 1881.
Little Log Shoals	1875	91	1.6	50	3	Do.
Tressel's	1875, 1881	1188	1.8	40	3	Do.
King's Mountain	1875	125	2.3	45	4	Do.
Cunningham's	1875, 1881	1016	1.6	50	3½	Do.
Bald Bar	1875	110	1.8	45	3½	Do.
Big Sandy	1875	150	2.6	50	4	Cut formed in 1877—good channel.
Vancleeve's	1875	113	3	60	4	Observed September, 1881.
McCown's	1875, 1881	612	1.8	50	3½	Do.
Mud Bar	1875	190	2	45	4	Do.
Wild Horse	1875	198	3	45	4	Do.
Beale's	1875	250	2.2	45	4	Do.
Buzzard's	1875, 1881	378	1.4	40	2.6	Unfinished. River forming new chute.
Eddin's	1875, 1882	225	2.6	......	......	Cut off formed in 1881.
Lily Wreck	1875, 1882	70	2.2	......	......	Work in progress.
Izzard's	1875	175	1.6	50	3	Observed, 1876.
Mike's	1875	232	2.3	50	4	Do.
Drop Out	1875	182	2	50	3½	Do.
Battle's Gin	1876	172	2.8	50	4	Do.
Washington	1876	490	4	80	4	Channel straightened.
Cut Off	1876	469	2.4	......	......	Condition not yet ascertained. Channel shifted in 1879 and 1880.
White's	1876	333	3.2	50	4	Observed in 1876.
Cleveland's	1876	559	1.8	45	3	Do.
Bohannon's	1876	258	3	50	4	Do.
Alligator	1876, 1878	929	2.3	50	3½	Observed in 1878.
Above Mary H	1876, 1878	383	2	55	3½	Do.
Coline's Island	1876, 1878	468	2.3	50	4	Do. New shoal below reported.
Log shoals	1876, 1878	1,645	1.2	50	4½	Observed in 1881 3' reported above shoals.
Hickman's	1878	1,355	1.6	45	3½	Observed in 1878.
Lower Choctaw	1878	170	2.3	55	4	Do.
Below Millwood	1881	130	2	50	3	River rose before completion, and depth uncertain.
Limestone Creek	1881	545	2	50	3	Observed at completion.
Above Myer's	1881	634	1.9	50	3	Do.
Below Myer's	1881	111	2	50	3½	Observed 2 weeks after completion.
Holcroft's	1881	285	2	50	......	Not examined; reported ample depth.
Laster's	1880, 1881	1,617	1.6	50	2.6	Observed at completion.
McIntyre's	1880, 1881	1,391	1.2	60	6.6	4' except rock bottom for 100' at head of shoal.
Little's	1881	620	2	60	3	Observed 15 days after improvement.
Tyndall's	1881	922	1.6	......	......	Depth reported ample, not; examined.
Drake's	1881	310	1.9	......	......	Do.
Log Yard	1881	345	2	50	3	Observed 1 week after improvement.
Yellow Creek	1881	535	2	50	2.6	4' except on rock reef at head of chute.
Tayloe's	1881	939	2	60	3	Observed at completion.
Devil's Run	1881	345	3	65	4.3	Observed 30 days after improvement.
Felter's	1881	732	1.6	60	3.6	Observed 23 days after improvement.
Below Felter's	1881	271	1.9	60	3.6	Observed 21 days after improvement.
Glover's Ferry	1881	551	1.6	60	3	Observed 5 days after improvement.
Above Mouth	1881	388	1.8	60	3½	Observed 2 days after improvement.

Working time spent on the above work, months	30
Linear feet of dams and jetties built	24,959
Number of logs taken out	4,790
Number of trees felled	7,125

The widths given in the above table are approximate and for the depths stated in each case.

The channel limit is usually 100 feet and over, and in no case less than 85 feet, but the section in bar chutes is usually triangular, with an excess of depth next the bank and shoaling gradually to the bar. For a full width of 80 feet it would be necessary to partially fill the apex of the triangle (probably by the use of submerged dams) and by the induced scouring give depth toward the bar. This has not yet been tried, as the width is, in all cases, ample for the class of boats navigating this river.

As is shown above, forty-eight bars have been materially improved, and there remain for improvement forty-eight others. For 40 miles above the mouth there is not less than 3 feet at low water (except 2½ at one place only), and for this distance small boats can run all the year; and the boating season to Tuscaloosa has been extended, from the fact that boats can now run through on 2 feet less water than formerly.

It is proposed to apply the funds available for expenditure during the fiscal year ending June 30, 1883, to completing the improvement at the Williford Cut-off, to establishing and maintaining the new chute forming at Buzzard's Bar, 4 miles above, and to complete the improvement at Jeanings' Ferry, opposite Eutaw. The results expected are to establish a permanent regimen for the river at the points named, besides affording the relief to navigation that the logging operations will give.

The amount that can be profitably expended during the fiscal year ending June 30, 1884, is $20,000. It is proposed to expend this amount in improving bars between Jeanings' Ferry and Millwood and thus give a low-water navigation throughout the river of probably 3 feet depth.

The estimated amount, exclusive of former appropriations, for the entire completion of the work is $75,000. The work will not be permanent; in other words it will be subject to deterioration and will require annual inspection and repairs.

It is thought that one steamboat will maintain the improvements on both the Warrior and the Tombigbee, and the Warriors' proportion of the annual cost of repairs and working expenses for this boat would be $5,000.

Mobile is the collection district in which this work is located, and it is also the nearest port of entry.

No commercial statistics pertaining to the business of this river are kept, except as to cotton. Statements, itemized as far as possible, have been promised by boat owners and officers, but not yet received.

During the past year the business of the river has been transacted by two boats. One of 700 bales capacity made regular trips (missing one) from July to November, in the lower portion of the river, availing itself of the improvements as fast as made up to Millwood, 40 miles from the mouth. The other boat, of 1,200 bales' capacity, has run through to Tuscaloosa from November to June; 9,520 bales of cotton were taken out of the Warrior River in 1881, 1882, as against 15,441 in 1880, 1881, and 15,263 in 1879, 1880.

Owing to the short cotton crop of last year, which was severely felt in the Warrior Valley, the business was unusually light.

As the river is at no point more than 15 miles distant from a railroad station, a large part of the business formerly done on the river is now transacted by rail.

When the completion of the improvement shall have put an end to the uncertainty and irregularity heretofore attendant upon river transportation, much of this business will naturally return to the river.

The average value of products and merchandise now annually transported by river, taking 15,000 bales of cotton as forming the bulk of the down freight, and estimating the return freight at 80 per cent. in value, would be about $1,350,000. As has been urged in former reports, the chief value of the river improvement to the community generally, as regards the present business of the Warrior Valley, whatever done by river or railroad, is the reduced rates of freight. Of late years the charges on cotton by rail have varied from $1 to $3 per bale, according as the river was or was not in condition to compete, and a corresponding variation was shown in all other freight.

With competition made permanent and uninterrupted the annual saving on the business of the Warrior Valley would not be less than $50,000.

The main element in the future increase of the business of the Warrior, due to its improvement, is the coal lying along the river and creeks for 100 miles above Tuscaloosa.

The inauguration of this business is dependent upon the establishing of slackwater navigation above Tuscaloosa, and its full development may very likely require an extension of this system of improvement to the lower river.

2.—TOMBIGBEE RIVER BELOW COLUMBUS, MISSISSIPPI.

From Columbus to the junction of the Tombigbee and Alabama is, by steamboat measurement, 366 miles. Its normal width below the mouth of the Black Warrior is about 300 feet; above, it is 150 feet. It was originally navigable for large boats only in the winter and spring for a period ranging from 4 to 7 months. During this time the river affords from 15 to 40 feet in depth, and the only obstructions were on this stage of water the overhanging trees, which, on dark nights and in foggy weather, not infrequently caused serious damage to steamboats. During low water, a season lasting from five to eight months, numerous bars affording only 18 to 22 inches water, together with the thickly strewn snags and sunken logs, made navigation both difficult and dangerous. In fact the head of summer navigation seldom extended above Demopolis, 243 miles from Mobile, and sometimes not above Bladen Springs, 100 miles below. Practically, for regular business, the Tombigbee before improvement was navigable in the summer and autumn for only 95 miles of the 366 that lie between Columbus and the mouth.

An examination of this river, provided for by act of July 11, 1870, was made during the winter of 1870–'71. Having been made during the high water season the report was unsatisfactory, and a re-examination was soon after made from Jones' Bluff, 292 miles from Mobile, to the mouth, and reported on April 17, 1871.

The original project adopted in 1871 was to widen the 40-foot channel at McGrew's Shoals, 122 miles from Mobile; to remove wreck and deepen shoal at Peavy's Landing, 130 miles from Mobile; to remove snags at Slater's, 152 miles from Mobile; to deepen bar at Osage, 155 miles from Mobile; to reconstruct wing-dam (built by State) at Pearson's, 188 miles from Mobile; to remove snags from Ten Mile Shoals, 13.23 miles below Columbus. The estimated cost was $21,500.

It afterwards became evident that a much more thorough improvement than at first proposed was easily practicable, and a modified project was adopted in 1879, having in view the attainment of a 4-foot channel of navigable width from the mouth to Demopolis, and a depth of not less than 3 feet from Demopolis to Columbus. The estimated cost of this improvement was $170,000.

Appropriations for this work have been made as follows:

By act June 10, 1872	$10,000 00	
Less amount transferred to Major McFarland, United States Engineers, and expended, above Columbus	4,667 05	
		$5,332 95

By act March 3, 1875, for Tombigbee and Black Warrior below Tuscaloosa	$25,000 00
By act August 14, 1876, Warrior and Tombigbee	15,000 00
By act June 18, 1878, Warrior and Tombigbee below Columbus	28,000 00
By act March 3, 1879, Warrior and Tombigbee below Columbus	20,000 00
By act June 14, 1880, $47,000 for Warrior and Tombigbee, of which for Tombigbee below Vienna	15,000 00
And from Columbus to Vienna	12,000 00
By act March 3, 1881, $25,000 for Warrior and Tombigbee, of which for Tombigbee below Vienna	7,978 72
And from Columbus to Vienna	6,382 98

Of the above appropriations, $89,694.57 have been made applicable to the Tombigbee below Columbus. Work upon this river was commenced in August, 1872, 102 miles from Mobile, and continued until December 18, 250 snags having been removed. The unexpended balance of the appropriation was then transferred to Major McFarland, as above stated, and the subsequent joint appropriations for the Tombigbee and Warrior not being sufficient to equip and carry on with advantage both improvements at once, work was confined to the latter river until September, 1878, when the boats and crews were moved to the Tombigbee.

SUMMARY OF ANNUAL STATEMENTS.

1878–1879.

Work was continued from September 12 to December 1, with a brief interruption from a rise of 17 feet about October 1. Work was resumed June 1, the river having remained above a working stage for six months; 137 miles of the river was passed over, work being confined to the shoalest bars.

Length of working season ....months	3½
Number of bars improved	5
Linear feet of dams and jetties built	3,305
Number snags and logs taken out	911

1879–1880.

During July the improvement of Hatcheetigbee Bar, 134 miles from Mobile, was finished, and that of Peavy's, 130 miles, commenced, but it having been decided that the remainder of the appropriation should be spent above Demopolis, a steamer was chartered as a tow-boat, and on the 1st August the boats reached the mouth of the Warrior, 1 mile above Demopolis and 244 from Mobile. After improving 20 miles of the river here, work was suspended on November 23, and the boats capable of further service sent to Mobile for repairs. On the 1st of May they were taken in tow, and on the 11th reached the foot of Ten Mile Shoals, 23 miles below Columbus.

Another force had been organized at Columbus on the 26th of August previous and worked to the head of the shoals, 13 miles below. This force suspended operations November 15; the boats were wintered at Columbus, and it resumed work June 1. The results for the fiscal year were:

Length of season, months	6
Number of bars improved	13
Linear feet dams and jetties built	5,888
Number of logs removed	1,267
Number of trees felled	826

1880–1881.

Work was continued on Ten Mile Shoals until September 1, when an interruption of three weeks occurred from a rise in the river. It was resumed, but to little advantage, as the river did not again reach a good working stage, and on November 9 the boats were laid up at Columbus. On the 20th of March they were taken out on a bar and calked. The log-boat was then set to work, and on May 23 a full force was employed between Columbus and the head of Ten Mile Shoals.

A channel 35 feet wide by 3 feet in depth was blasted through Rock Shoals 2½ miles below Columbus.

The work for the year was as follows:

Time occupied on the work ....months..	7½
Number of bars improved	9
Linear feet of dams and jetties built	5,971
Number of logs taken out	1,195
Number of trees cut	587
Cubic yards of rock removed from channel	300

PROGRESS OF THE WORK DURING FISCAL YEAR ENDING JUNE 30, 1882.

On July 1, the working party below Columbus, in charge of Assistant H. B. Warren, was at the head of Ten Mile Shoals.

The outfit and force consisted of a log-boat with a crew of twelve men, and a quarter-boat, barge, and camp equipage for twenty-five men. Work was continued down through Ten Mile Shoals, improving four bars hitherto untouched, and making repairs and additions as found advisable to the seven improved the year previous. On September 25, Mr. Warren reached the foot of the shoals, and then proceeded under instructions to improve such bars only as afforded less than 2 feet water.

The object designed was to effect a partial, but much needed, improvement, as far down as Vienna, it being impossible to secure a 3-foot channel throughout during this season.

The point reached by this force was Street's Island, 58 miles below Columbus.

During June, 1881, a steamboat had been bought and fitted up for the Tombigbee River improvement, and on July 1 she left Mobile. There being a good stage of water in the lower river, the boat commenced work, removing logs between Demopolis and Jones' Bluff. But by the last of the month the river became very low, and trouble was reported at Rainwater Bar, 29 miles below Demopolis.

There had been no difficulty at this bar for many years, but of late the channel had been shifting, and this season the old channel closed without giving a new one of sufficient depth for navigation. Finding it difficult to deepen the new channel on account of its hard bottom, the old one was restored by building 865 feet of rock and brush jetties and training dikes.

Turner's Shoals, 152 miles from Mobile, next demanded attention. These shoals had been improved by the State many years ago by a wing-dam from the left bank, which caused the right chute to scour down to the rock, giving a depth of 4 feet.

A land-slide some years ago partially obstructed this chute, shoaling it to 2 feet, and the other chute was opened and again used, affording, until this year, 3 feet of water. But this season, in low water, the boats grounded in either chute.

A rock dike 550 feet long was built, restoring and lengthening the State dam, and the 4-foot channel on the right was reopened. After this the snag-boat returned up the river, and two bars, 5 and 20 miles above Demopolis, were improved.

A third, near Gainesville, was commenced, but left incomplete in order to amend the work at Turkey Shoals. This bar, since its improvement in 1878, had at no time been observed to afford less than 3½ feet of water, but was now reported as giving not less than 2 feet. This was found to be the case, and the shoaling appeared to have been caused by the leveling of a gravel "middle ground" in the center of the chute, across which a strong current swept, scouring the gravel from its crest and depositing it in the channel.

The trouble here, as well as at Rainwater and Turner's shoals, was also partly due to the extreme low water of this season, which was 6 feet below any observed since the work was commenced in 1878.

By repairing some of the old work with rock, and building 850 feet of new jetties, a channel was scoured out to 3 feet, but as the river rose several feet before completing the work, the full result at low water was not ascertained.

As the end of the working season was now approaching and earnest requests had been made to open a passage through the logs at Street's Island, which was the most serious obstacle now remaining on a 3-foot stage (above low water), the snag-boat was sent to that point, 15 miles above Vienna, where the force under Mr. Warren had just commenced work. The river was already rising, but it was found practicable to continue work for a week, and in that time the object of the trip was accomplished.

The improvement at this point was not completed, but a passable opening through the log obstructions was made. On November 27 work was suspended. The log-boat and quarter-boat, having become unserviceable and not worth repairing, were dismantled and sunk in jetties. The barge was taken with the snag-boat to Mobile. During the winter the engines and boilers of the snag-boat were repaired, two fore and aft bulkheads placed in the hole to stiffen the hull, and shears placed across the bow in place of a mast and boom that had proved unsatisfactory. On the 15th of March the snag-boat, with barge in tow, left Mobile, and until May 1 was occupied in cutting leaning timber from the bluffs and bar chutes, and trees from the "short points" between Jones's Bluff and Vienna.

At this time the river rose to 45 feet, and the snag-boat returned to Jones's Bluff, where the crew was employed in blasting off a rock point above the Alabama Great Southern Railroad Bridge, which, projecting 40 feet into the river, renders one draw opening impassable and causes a diagonal current through the other, making its passage often difficult and dangerous, and in the night-time generally impracticable. In its present condition this bridge is regarded by pilots as the most dangerous obstacle on the river, and the improvement undertaken is warmly recommended and approved by them. On the 29th of May, the river having fallen to a working stage, the snag-boat was sent above Vienna to work as a log-boat, and is still engaged there in that capacity.

The work for the year is as follows:

Working season, months	8
Additional bars improved	17
Linear feet dams and jetties	9,336
Number of logs removed	1,176
Number of trees cut	5,230
Number of cubic yards rock bluff blasted	1,100

The following table gives the names and location of the bars improved, with the effects produced as last observed:

BELOW DEMOPOLIS.

Names.	Miles from Mobile.	Linear feet of dams and jetties built.	Original depth.	Present width, approximate.	Present depth.	
Peavy's	130	275	2'-3'	....	......	Unfinished depth varies with tide.
Hatcheetigbee	134	653	2'-3'	100	3'-4'	Do.
Turner's Shoals	151	550	2'	85	4'	Observed immediately after improving.
Osage	152	895	2'	65	4'. 2	Observed three years after improving.
Seller's	153	935	2'. 2	50	4'. 3	Do.
Barney's	169	175	2'. 3	50	4'. 6	Do.
Turkey Shoals	205	1, 700	1'. 8	40	3'	Observed before finishing improvement.
DEMOPOLIS TO VIENNA.						
Mouth of Warrior	244	305	1'. 10	55	3'. 3	Observed two years after improving.
Hancock's	246	520	1'. 10	50	3	Do.
The Rocks	246½	541	1'. 6	50	3'	Do.
Bee Tree	247	382	2'	35	3'	Do.
Green's	249	366	2'	50	......	Not observed after completion estimated 3 feet.
Arrington's	251	120	2½'	50	3'	Observed two years after improving.
Haunted Point	253	805	1'. 8	55	3'	Do.
Birdine	256	971	1'. 6	45	3'	Do.
Lipscomb's Gin	259	135	2'. 3	50	3'	Do.
Blacksnake	261	891	1'. 6	45	3'. 2	Do.
Rattlesnake	262	300	2'	50	3'	Observed immediately after improving.
Howard's	309	150	1'. 6	40	2'. 6	Unfinished.
VIENNA TO COLUMBUS.						
Street's Island	358	166	1'. 2	35	3'	Unfinished shallow, mainly from logs.
Clanton's	366	327	2'	Not less than 35 feet.	3'	Observed immediately after completion.
Shylock's	376	306	12"		2'. 3	Do.
Coal Fire	384	644	12"		2'. 4	Do.
Dorsey's Ford	385	553	2'. 4		3'. 2	Do.
Nashville	391	250	1'. 6		2'. 6	Do.
Ten-mile Shoals, 11 bars.	393 to 403	9, 625	14"-20"		2'. 8-3	Do.
Butler's	410	340	14"		3'	Do.
Gaston's	413	600	16"		2'. 8	Do.
Rock Shoals	413½	......	12"	35	3'	Channel excavated.
Huddleston's	414	250	16"	35	3'	Observed immediately after improving.
Curtis Island	415	175	12"	35	3'	Do.

Total linear feet of dams and jetties	12, 236
Number of logs removed	4, 549
Number of trees felled	6, 643

As will be seen from the above table forty-two bars have been improved, mainly those that most impeded low water navigation. In order to complete the improvement as projected, it will be necessary (besides occasional additions to work already done) to improve—

Below Demopolis, twenty-one bars.
From Demopolis to Vienna, forty bars.
From Vienna to Columbus, fifteen bars.

The improvement as far as perfected has extended extreme low water navigation from Bladon, 145 miles above Mobile, to Durden's, 264 miles, and has added from two to three months to the length of the boating season to Columbus. Cutting the leaning timber from the banks and trimming the "short points," besides lessening the risk of damage to boats, has, in the estimation of pilots, reduced the length of the trip between Mobile and Columbus fully twelve hours.

The removal of the logs has added greatly to the safety of navigation, and no boat has been sunk since the improvement was commenced.

It is proposed to apply the funds available for expenditure during the fiscal year ending June 30, 1883, as follows:

1st. *Columbus to Vienna.*—In building a log-boat, barge, and quarter-boat, at a cost of $3,500; to continue removing logs still in the channel between Ten Mile Shoals and Vienna, a distance of 50 miles; and to continue improvement of bars.

It is expected that the results will be to increase the facilities for low-water navigation, and add to the duration of the boating season.

2d. *Vienna to Demopolis.*—It is proposed to complete the removal of the rock point above the Alabama Great Southern Railroad Bridge at Jones's Bluff, and to continue the removal of logs between Jones's Bluff and Vienna, 56 miles.

The effect will be to open some bar chutes now obstructed by logs at low water, and to make a safe passage, without delay at night in passing through the draw-bridge.

3d. *Below Demopolis.*—It is proposed to examine the three bars improved last year, and make additions to the work, if found necessary to finish the improvement commenced at Peavy's in 1879, and to remove logs below Jackson (110 miles), which, though not in the way at ordinary low water, are reported as dangerous whenever a continued north wind, causing an extreme low-tide, occurs at low water.

The amount that could be profitably expended during the fiscal year ending June 30, 1884, is—

Between Columbus and Vienna	$9,000
Between Vienna and Demopolis	11,000
Below Demopolis	21,000

It is proposed to expend these amounts—

1st. In completing a 3-foot channel of not less than 35 feet width between Columbus and Vienna, giving continuous navigation on this section of the river. Revising this work the succeeding year would probably perfect the improvement, so as to leave nothing further needed but annual inspection and maintenance.

2d. In improving fifteen bars of least depth between Vienna and Demopolis, and in removing all channel logs, the probable effect being to give not less than 2½ feet low water depth on this division.

3d. In improving eight bars of least depth (two of them rock shoals) below Demopolis, with the expectation of securing a channel depth throughout of not less than 3½ feet.

The estimated amount, exclusive of appropriations already made for the entire completion of this work, is:

Columbus to Vienna	$16,000
Vienna to Demopolis	30,000
Below Demopolis	42,000

On a large portion of this river the banks are unstable, being of alluvial formation.

A shifting of the river bed in some places may, therefore, be occasionally expected, and fallen timber will lodge at times, and form obstructions. Consequently the improvement effected will not be permanent, but will require slight annual repairs and amendments.

A yearly appropriation of $5,000 will suffice for this purpose, that being one-half the estimated annual cost of repairs and working expenses of one steamboat, that it is thought would be able to maintain the improvements upon the Tombigbee and Warrior.

The collection district in which this work is located is Mobile, which is also the nearest port of entry.

COMMERCIAL STATISTICS.

Six steamboats from Mobile and one from Columbus have been navigating the river during the past year. Their capacity ranges from 600 to 1,200 bales of cotton, and draught from 2 feet to 6½ feet.

Many timber rafts and flat-boats loaded with staves also floated down the river, but their number or value could not be ascertained. A full itemized statement of the business done on the river is impossible, from the fact that no records of receipts and shipments are kept, except as to cotton.

Through the kindness of Capt. J. G. Stewart, secretary of the Merchants' and Planters' Line, of Mobile, and Moore & Cox, merchants of Columbus, the facts given in the letters subjoined are presented:

MOBILE, ALA., *June* 1, 1882.

* * The following is a close statement of the business of the Bigbee River from June 1, 1861, to May 31, 1882:

10,500 passengers, up and down.
32,000 tons of up freight, consisting principally of bacon, flour, corn, meal, assorted groceries, fertilizers.
1,500 tons lumber, bagging and ties, shingles, &c.
45,557 bales of cotton.
82,000 sack cotton-seed to Miller's Landing and Demopolis.
3,000 barrels spirits turpentine.
15,000 barrels rosin.

This industry will be doubled next year, as additional stills are going into operation.

There are also considerable shipments of poultry, eggs, wool, bees-wax, and cattle, that I can't estimate.

Yours, truly,

JAS. G. STEWART.

Moore & Cox give the following statement of the business of the *Billy Collins*, running from Columbus to Alabama Great Southern Railroad, at Miller's Landing, for years 1881–'82:

7,010 bales of cotton from Columbus to Miller's.
1,117 bales of cotton from way landings to Columbus.
6,588 sacks cotton-seed to Columbus.
4,195 sacks guano to and from Columbus.

In addition to the above, about 100 car loads of miscellaneous merchandise.

Mobile and Ohio Railroad rates.	Low-water.	High-water.	Difference.
Cotton per cwt	$1 20	$0 65	$0 55
Meat per cwt	79	65	14

Other merchandise in proportion. * * * The above shows what one little boat has done for us on her first [second] season, and demonstrates how great would be the saving if our river was open all the year round to light-draught boats. Take our cotton crop alone this season, our receipts have been about 30,000 bales, which at the above difference of 55 cents per 100 pounds ($2.75 per bale) would make us a saving of $82,500, and a probably much larger one on up freights. * * *

Yours, truly,

MOORE & COX,
Per A. C. LEE.

Owing to the short cotton crop in this section, shown by the fact that Mobile receipts up to June 1 were 258,717 bales as against 378,469 bales for same time last year, the business above shown was probably one-fourth less than usual.

The receipts of cotton in Mobile from the Tombigbee for the two years preceding the last have been as follows:

1879-1880	$76,878
1880-1881	66,324

IMPROVEMENT COMMENCED SEPTEMBER, 1878.

The business now done in cotton-seed, fertilizers, rosin, and turpentine is mostly of recent development.

Future increase in business, due to the completion of the improvement, will occur chiefly in the summer and autumn in consequence of regular navigation being made practicable during those months.

When the cotton season opens, September 1, the river is generally low and remains in that condition until December 1. During this time an average amount of 60,000 bales of cotton is carried by the Mobile and Ohio Railroad to Mobile, much of which is hauled from river plantations 20 miles or more to the railroad.

A large part of this cotton will take river transportation when the facilities promised by this improvement shall be afforded.

The chief economic value of the improvement will be felt in the reduction of freight rates caused by the competition between river and rail. This is alluded to in the letter of Moore & Cox.

The estimated annual saving in transportation charges for the Tombigbee Valley (including the Warrior Valley) is $150,000.

Two-thirds of this amount ($100,000) would be the estimated saving for the Tombigbee Valley alone.

Money statement.

July 1, 1881, amount available	$50,709 26
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	42,776 57
July 1, 1882, amount available	7,932 69
Amount appropriated by act passed August 2, 1882	30,000 00
Amount available for fiscal year ending June 30, 1883	37,932 69
Amount (estimated) required for completion of existing project	148,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	61,000 00

K 15.

IMPROVEMENT OF TOMBIGBEE RIVER ABOVE COLUMBUS, MISSISSIPPI.

The survey of the Tombigbee River between Columbus and Fulton, Miss., was completed in 1873, under the direction of Maj. W. McFarland, Corps of Engineers, U. S. A. The project adopted for the improvement of this portion of river was to remove the snags, logs, and overhanging trees, so as to enable steamboats to run between the points mentioned during high-water, and the cost was estimated at $35,000.

The sum of $10,000 was appropriated for the improvement of the Tombigbee River by act of Congress approved March 3, 1873, of which $4,667.05 was expended by Major McFarland above Columbus, and the balance, under the direction of this office, on the lower part of the river.

No other work was done on the upper river until 1878. Commencing with that year this improvement was assigned to the charge of this office, and appropriations have been as follows:

Act of Congress approved June 18, 1878	$12,000
Act of Congress approved March 3, 1879	10,000
Act of Congress approved June 14, 1880	4,000
Act of Congress approved March 3, 1881	1,000

Operations under these appropriations were commenced at Aberdeen, Miss., in 1878, and have been carried on from that time, during low water seasons, to the close of this fiscal year in accordance with the adopted project. When the work was commenced the condition of the river was as follows: From Columbus, Miss., up to Aberdeen, 65 miles (estimated distance), navigation was difficult when the water was 12 feet above ordinary low water; between Aberdeen and Cotton Gin Port, 35 miles (estimated distance), there was only navigation for small barges, carrying about 125 bales of cotton; from Cotton Gin Port up to Fulton there was no navigation at all.

During the last fiscal year operations were confined principally to the 40 miles mentioned in the previous annual report as having been passed over in high water and only partially improved.

During the previous year the improvement, more or less thorough, had been carried on over the whole portion of the river covered by the project.

The improvement, as projected, may now be considered as completed, as there is now easy navigation for steamboats of 300 tons from Columbus up to Aberdeen when the water is 4 feet above the ordinary low-water stage, and from Aberdeen up to Fulton when it is 10 feet above. A light-draught steamer was employed on it during the last cotton season.

The improvement is not permanent, but it is thought that an annual appropriation of $2,000, with the balance on hand, will preserve the improvement effected, and perhaps obtain a still better condition of the channel.

During the year 1880, 2,000 bales of cotton were shipped down the river, between Fulton and Aberdeen. During the year 1881, 4,063 bales of cotton were shipped down the river between Fulton and Cotton Gin Port, and 8,000 bales from Aberdeen. During this year the shipments down the river from different points aggregate about 21,786 bales.

No record could be obtained of up freights, but for each year would probably amount in value to more than 75 per cent. of that of the cotton down. About 6,000 logs have also been shipped down the river from above Aberdeen during this year.

The aggregate saving this year on freights, due to the improved condition of the river, cannot be closely estimated, but will probably exceed $75,000.

This work is in the collection district of Mobile, Ala. Mobile, Ala., is the nearest port of entry.

Money statement.

July 1, 1881, amount available	$9,848 72
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	5,475 32
July 1, 1882, amount available	4,373 40
Amount appropriated by act passed August 2, 1882	1,000 00
Amount available for fiscal year ending June 30, 1883	5,373 40
Amount (estimated) required for preserving improvement	2,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	2,000 00

K 16.

IMPROVEMENT OF NOXUBEE RIVER, MISSISSIPPI.

The examination of this river provided for by act of Congress approved March 3, 1879, from Macon, Noxubee County, Mississippi, to its mouth, was made during the months of November and December, 1879. The report was made during the month of March, 1880, and is contained in the Annual Report of the Chief of Engineers for 1880.

The condition of the river when examined was such that, during all seasons of the year, and at all stages of water, navigation, except by small flat boats, was practically impossible. Steamboats formerly plied upon the river, but, after the building of the Mobile and Ohio Railroad they were withdrawn (in 1856). The river banks then became overgrown with timber, which in time fell or slid into the river, causing snags and logs to lodge on the river bottom, and also caused the formation of shoals and bars. The river being virtually abandoned for the purposes of navigation, the planters living along its banks assisted in closing up its channel-way by building a number of fish traps and mill-dams.

The chief obstructions consisted in the immense number of trees overhanging its banks, which appeared throughout its entire length, in some places being so dense as to roof the river in.

During the low water season the average depth of the river is fully 3 feet, but there are a number of shoals and bars on which only 1½ and 2 feet of water can be found. The river has an average width of 60 feet at low water, which increases very considerably during the season of high water.

The project adopted was designed to obtain a navigable channel during nine months of the year from the mouth of the river to the city of Macon, Mississippi, by the removal of such overhanging timber and other obstructions as were to be found on that portion of the river. The estimated cost was $65,245.25.

The appropriations for the work are as follows:

By act of Congress approved June 14, 1880	$12,000
By act of Congress approved March 3, 1881	8,000
Total	20,000

Work was commenced on the improvement during the low water season of 1880, prosecuted through the fiscal year ending June 30, 1881, and continued during the fiscal year ending June 30, 1882, until the funds available for the work were exhausted.

The work performed during the fiscal year ending June 30, 1881, was as follows:

Overhanging and leaning trees removed	7,851
Large trees trimmed of overhanging limbs	642
Stumps on bank cut level	2,718
Logs on bank cut up (drift)	1,029
Logs removed from bed of river	1,176
Fish traps removed	2
Snag-boat built and fitted up	1
Quarter-boat built and fitted up	1
Number of miles of river worked over and partially improved	38

During the fiscal year ending June 30, 1882, the work of improvement, according to the plan adopted, was vigorously prosecuted until an exhaustion of the available funds rendered a suspension of operations necessary. The work accomplished is summarized as follows:

Number large overhanging trees felled	20,553
Number large overhanging trees trimmed	1,062
Number logs (drift and fallen timber) on the banks, cut up	1,949
Number large stumps on bank cut level	2,732
Number logs and snags removed from river	1,675
Number fish traps and drifts removed	10
Number miles of river worked over	36
Number miles of river worked over during previous years	38

TOTAL WORK ACCOMPLISHED FROM COMMENCEMENT OF IMPROVEMENT TO END OF PRESENT FISCAL YEAR.

Large overhanging trees removed	28,404
Large overhanging timber trimmed	1,724
Large stumps on bank cut level	5,450
Logs on bank cut up (drift)	2,978
Logs and snags removed from river bed	2,857
Fish traps and drifts removed	12
Quarter-boat built and equipped	1
Snag-boat built and equipped	1
Total number of miles worked over (partially improved)	74
Number of miles of river remaining to be worked over	17½

Owing to the work of improvement not being completed the river as yet is not available for the purposes of navigation and commerce. Advantage of the incomplete improvement was, however, taken last fall to send a small steamboat up the river for a cargo of cotton; she proceeded some 45 miles without any difficulty, but was compelled to return on meeting with a heavy drift, which had accumulated after the working party had withdrawn.

This is the first attempt to navigate the river that has been made within the last twenty-five years.

It is proposed to apply the funds that may be available for expenditures during the next fiscal year to continuing and completing the improvement according to the project adopted.

On completing the improvement as designed the river during the high-water season will be navigable from its mouth to the city of Macon, Miss., thus furnishing a new and cheaper transportation route to the the planters who reside on or adjacent to the river for their cotton, produce, and supplies, the greater portion of which is now hauled over the heavy prairie roads from long distances to the different stations on the Mobile and Ohio Railroad.

The sum of $25,000 can be profitably expended during the fiscal year ending June 30, 1884, in continuing the improvement by widening and deepening the channel, and removing the snags and logs which will find their way into the bed of the river after each freshet.

The work is not susceptible of permanent improvement, and will require an annual appropriation of $3,000 to maintain the river in the condition contemplated by the plan of improvement.

The work is situated in the collection district of Mobile, Ala., and Mobile is the nearest port of entry.

No commerce has yet been able to take advantage of the work accomplished owing to its incomplete condition, and no vessels have as yet used the river for purposes of navigation, except the one instance mentioned.

The shipments over the river after the improvement is completed are estimated at about 16,000 or 18,000 bales of cotton, and an equal value of other products and return supplies.

The estimated value of commerce will be about as follows:

Say 16,000 bales of cotton, at $55 per bale	$880,000
Cotton-seed, corn, and other products, say	100,000
Return merchandise and plantation supplies, say 80 per cent. of above value.	784,000
Total	1,764,000

This may possibly be increased by the improvement furnishing the means of supplying coal to the inhabitants adjacent to the river, from the coal-fields of the Sipsey and Warrior rivers.

Money statement.

July 1, 1881, amount available	$7,638 84
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	7,637 29
July 1, 1882, amount available	1 55
Amount appropriated by act passed August 2, 1882	10,000 00
Amount available for fiscal year ending June 30, 1883	10,001 55
Amount (estimated) required for completion of existing project	35,245 25
Amount that can be profitably expended in fiscal year ending June 30, 1884.	25,000 00

K 17.

IMPROVEMENT OF PASCAGOULA RIVER, MISSISSIPPI.

The project for the improvement of the river at its mouth, by dredging a channel 200 feet wide and 7 feet deep at mean low water, through the bar, dates back as early as 1873, when a survey was made and plans submitted by Lieutenant Quinn, U. S. A. This project was received in 1880, and in April of that year the contract for dredging was awarded to Mr. S. N. Kimball, the amount available being $22,500. This was exhausted in January, 1881; 63,000 cubic yards of material were removed.

By an act of Congress, approved June 14, 1880, $20,000 was appropriated to complete the dredging at the mouth, and to commence the further improvement of the river for its entire length, by the removal of snags and overhanging trees.

The second dredging contract was awarded to Mr. W. G. Mitchell, in November, 1880, who commenced digging in March, 1881, but owing to many delays this work was not finished until March, 1882.

At the commencement of this improvement there were from 3 to 3½ feet on the bar at the mouth of the river, at mean low water, and in the winter months lumber-lighters were frequently detained here for several days, often unloaded their cargoes, floated the lumber over the bar and reloaded in deeper water. Large demurrage bills were frequently paid.

A channel has been successfully dredged through this bar more than 1 mile in length, 180 to 190 feet wide, which is believed to be ample, and from 7½ to 8 feet deep at mean low water, 118,996 cubic yards of material having been removed.

A recent examination shows that this condition has been preserved, and it may reasonably be expected that it will be fully maintained so long as tugs drawing nearly as much water as the channel contains pass through it. Vessels which were formerly loaded from lighters at the anchorage in Mississippi Sound now pass through the cut up the river and load at the mills at Moss Point, to from 8 to 8½ feet, and pass out to sea without delay or obstruction.

No demurrage claims, due to shallow water over the bar, have been paid during the past year. In a word, the condition of this improvement is highly satisfactory, and the dredged channel is a pronounced success.

Clusters of creosoted piles mark the east line of the cut, and the Light-House Department contemplates placing a beacon-light at the mouth of the cut to facilitate navigation.

With the unexpended balance, about $4,000, and the funds which may be available for expenditure during the next fiscal year, ending June 30, 1883, it is proposed to commence the removal of snags and overhanging trees up the river. A suitable log-boat has been constructed and is ready to begin this work at once, as soon as the river is in proper condition. This part of the improvement it is expected will give very beneficial results, enabling the lumbermen, turpentine and rosin manufactories to transport their produce to the mills and market, at low water, without obstruction.

In view of thus opening up the navigation of the river, new and large lumber mills are being constructed at Moss Point; turpentine and rosin manufactories are developing, vacant lands being occupied, and real estate, generally, increasing in value along the river.

By referring to the report of Mr. Powhatan Robinson, assistant engineer, who made an examination of this river in 1879, it will be seen that it can be rendered navigable by vessels drawing over 5 feet for more than 80 miles, by removing the snags and overhanging trees. The value of this improvement cannot now be fully estimated, but it is safe to say that the shipments of lumber, charcoal, naval stores, &c., will be more than doubled. The sum of $10,000 can be profitably expended on this river for improvements during the fiscal year ending June 30, 1884. This amount will probably complete the improvement under the present project. A small annual appropriation may be necessary thereafter to maintain the river in the condition contemplated by the plan of improvement, but a close estimate cannot yet be made of the amount.

This work is situated in the collection district of Shieldsborough, Miss., Pascagoula being the port of entry, where there is stationed a deputy collector.

The appended custom-house statistics for the fiscal year ending June 30, 1882, will show the entrances, clearances, and custom-house receipts for the past year, and also for the years previous to the commencement of the improvement. The tabulated statement appended will also show the value of the commerce of Pascagoula River, which does not appear in the custom-house statistics.

Money statement.

July 1, 1881, amount available	$22,429 56
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	20,083 84
July 1, 1882, amount available	2,345 72
Amount appropriated by act passed August 2, 1882	8,000 00
Amount available for fiscal year ending June 30, 1883	10,345 72
Amount (estimated) required for completion of existing project	10,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	10,000 00

Comparative custom-house returns, Pascagoula River.

ENTRANCES.

Year.	Number of vessels.	Tons.	Total.	
			Number.	Tons.
1879	American, 28	6, 007		
	Foreign, 36	16, 379	64	22, 386
1880	American, 19	4, 542		
	Foreign, 42	19, 189	61	23, 731
1881	American, 24	7, 007		
	Foreign, 84	40, 633	108	47, 640
1882	American, 18	6, 342		
	Foreign, 85	51, 465		
	Coastwise, 2	1, 419	105	59, 226

CLEARANCES.

Year.	Number of vessels.	Tons.	Total.	
			Number.	Tons.
1879	American, 25	5, 831		
	Foreign, 36	17, 085	61	22, 916
1880	American, 21	4, 332		
	Foreign, 43	20, 259	64	24, 491
1881	American, 16	4, 055		
	Foreign, 77	36, 326	93	40, 381
1882	American, 42	20, 080		
	Foreign, 90	53, 247		
	Coastwise, 3	874	135	74, 151

List of clearances and statement of lumber shipments from Pascagoula, Miss., fiscal year ending June 30, 1882.

Number of vessels.	Tons.	Superficial feet.	Value.	Cubic feet.	Value.
American, 42	20, 080	10, 949, 102			
Foreign, 90	53, 247	18, 326. 60	$275, 893	1, 500, 570	$185, 895
Coastwise, 3	874	646, 114			

Custom-house receipts from all sources, $11,581.12.

Approximate tonnage on Pascagoula River, Mississippi.

No. vessels.	Character.	Average tonnage.	Total tonnage.
6	Steam tugs	50	300
7	Schooners, large	150	1, 050
30	Schooners, small	25	750
22	Barges	100	2, 200

K 18.

EXAMINATION OF FINHOLLOWAY RIVER, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., August 26, 1881.

SIR: I have the honor of submitting the following report upon the examination of the Finholloway River, Florida, authorized by act of Congress approved June 14, 1880, and assigned to me by letter dated June 17, 1880.

The river was found to have but 2 feet depth at low-water at its mouth, the bar there being formed of mud banks, oyster and rock reefs, extending about 3 miles seaward.

From inside the bar, up about 3 miles, it has a width of from 150 to 200 feet, and from 12 to 15 feet depth, but the channel is crooked, being obstructed by large rocks. In the next mile the river contracts to a width of 100 feet; four miles above the mouth of the river is a ledge of rocks running across with a reported depth of about 2 inches at low-water, and extending up about 3 miles; above this the river expands into a pool called Dead River which extends to the head of the hammock lands, 12 miles from its mouth.

There is an abundance of palmetto, cedar, and live oak on the river, in which there is a small business, the logs being floated down.

The amount of the business now carried on could not be ascertained, but is small.

The cost of any considerable improvement would be very great, but no accurate estimate can be made, and it is not believed the importance of the river would justify a survey to obtain data for one.

The report of Mr. Powhatan Robinson, by whom the examination was made, is transmitted herewith, and to it I would respectfully refer, particularly in connection with his opinion as to the interest to be benefited by any improvement.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. POWHATAN ROBINSON, ASSISTANT ENGINEER.

MOBILE, ALA., *January* 17, 1881.

MAJOR: In pursuance of your orders of October 22, 1880, I have made an examination of Finholloway River, in Northwestern Florida, with a view towards its improvement, and I now have the honor to submit the result of my observations.

The approach to this river, as to most rivers on this coast, is obstructed for about 3 miles seaward by mud banks, oyster beds, and, in this particular case, rock reefs. A vessel cannot carry more than 2 feet draught over the bar at low-water, but by waiting from 12 to 24 hours she may carry 4 or 5 feet.

Entering the river, we find a depth from 12 to 15 feet water; but the channel is very crooked, owing to large rocks scattered in the channel, and reaching, in some cases, above the surface of low-water, but in others hidden a little below it. At 3 miles above the mouth we come to what I term "Island No. 1." The river up to this point has a width from 150 to 200 feet, but it now contracts to 100 feet or less. Four miles above the mouth we reach the foot of "Island No. 2." This island is about 3 miles long, and divides the river into two narrow channels running over a ledge of rocks—said to be limestone—which I am told underlies the entire bed of the river throughout the length of the island. At low-water I am informed that the depth in either channel will average about 2 inches.

It would require an excavation of about 34,000 cubic yards of rock to open a channel 30 feet wide by 2 feet deep, at a minimum cost of $2.50 per cubic yard; and when completed there would be a want of water to fill it. This, I think, settles the question of navigation.

This ledge of rock seems to act as a sort of dam, for above it the river expands into a pool called Dead River, which extends to the head of the hummock lands, 12 miles above the mouth. Lumber is the sole product of this region for market. For about 3 miles above the mouth there is an abundance of palmetto; also cedar, and a good deal of live oak. The cedar is said to be of poor quality, being gnarled, and windshaken by the coast storms. But above this the cedar is of fine quality, extending up to the head of Dead River. No lumber has been brought to market from any point above this. The lumbermen let their logs drift singly down the river, and collect them at some point below the islands. If anything should be done for this little stream, I would recommend that the drifting plan be continued, and that only such trees and snags be removed as may interfere with the drifting of single logs at medium stage of water. On this plan I think that $500 will pay for all work necessary between the mouth and the head of Dead River, 12 miles above. The only interest I know of to be benefited by the modest appropriation I have suggested is that of stripping the public lands of their timber.

* * * * * * *

I am, major, very respectfully, your obedient servant,

POWHATAN ROBINSON,
Assistant Engineer.

Maj. A. N. DAMRELL,
Captain, Corps of Engineers, U. S. A.

K 19.

EXAMINATION OF AUCILLA AND WACISSA RIVERS, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., August 26, 1881.

GENERAL: I have the honor of submitting the following report upon the examination of the Aucilla and Wacissa rivers, Florida, provided for by act of Congress approved June 14, 1880, and assigned to me by letter dated June 17, 1880.

The Aucilla was found to have a bar, composed of mud and oyster beds, at its mouth, extending about 3 miles seaward, and with sufficient depth to permit vessels of 2½ feet draught to cross at low-water, and about 5 feet at high-water.

Six miles above the mouth commences a series of natural bridges, 12 in number, varying in width from 20 feet to half a mile, separated from each other by open portions of the river from 450 feet to three-fourths of a mile long, which covers nearly 12 miles of the river with a complete obstruction to navigation. The thickness of these bridges and the depth of water beneath were not ascertained, time and stage of water not permitting, but it is believed from information obtained from observation of parties living in the vicinity that the depth under the bridge is sufficient to allow of the material being dropped down by blasting. The aggregate transverse length of the bridge is about 1⅙ miles.

The valley of the river is very productive, and Jefferson County, of which it forms the east boundary, is one of the richest and most productive in the State. Madison County, on the east side, is also a rich county. The products are cotton (sea-island and short staple), sugar, molasses, corn, rice, &c. Timber is also abundant and of the best quality.

The river not being now navigated to a sufficient distance up, there is no commerce of any importance. or none that could be ascertained.

The examination would seem to indicate the river and adjacent country are such as to merit a careful survey.

The Wacissa is a very short stream, about 10 miles long, with an abundance of water, which empties into the Aucilla 5 miles above its mouth, and requires the removal of some logs which now obstruct its channel, at an estimated cost of about $300, provided it is undertaken at the same time as the improvement of the Aucilla, so that the same outfit could be used for both.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. POWHATAN ROBINSON, ASSISTANT ENGINEER.

MOBILE, ALA., *January* 17, 1881.

MAJOR: In pursuance of your orders of October 22, 1880, I have made an examination of the Aucilla and Wacissa rivers, in Northwestern Florida, with a view toward their improvement, and I now have the honor to submit the results of my observations.

The approach to this river is obstructed by mud banks and oyster beds for about 3 miles seaward. A vessel may carry a 2½ feet draught over the bar at low-water, and 5 feet or more at high-water. But all navigation is effectually barred by a notable formation, commencing 6 miles above the mouth of the river and extending upward into the 12th mile. This consists of a series of rock or shale ribs extending entirely across the river, and designated as "natural bridges" by the neighboring citizens.

There are 12 of these, and I give their dimensions and positions as stated to me by persons who live on the spot.

Bridge No. 1, ½ mile wide; then open river three-fourths mile.
Bridge No. 2, 900 feet wide; then open river 2 miles.
Bridge No. 3, 75 feet wide; then open river 1,200 feet.
Bridge No. 4, 20 feet wide; then open river 450 feet.
Bridge No. 5, 35 feet wide; then open river one fourth mile.
Bridge No. 6, 50 feet wide; then open river one-fourth mile.
Bridge No. 7, 450 feet wide; then open river one-fourth mile.
Bridge No. 8, 300 feet wide; then open river 500 feet.
Bridge No. 9, 300 feet wide; then open river 500 feet.
Bridge No. 10, 300 feet wide; then open river one-fourth mile.
Bridge No. 11, 450 feet wide; then open river one-fourth mile.
Bridge No. 12, 600 feet wide; last bridge.

Some of these bridges are cultivated and produce abundantly, although at the time of full fresh the water runs 3 feet deep over the highest of them. The low-water level corresponds very nearly, I think, with the soffits (if I may so call them) of the bridges.

* * * * * * *

Inquiring about the thickness of the bridges and the depth of the stream beneath them, with a view toward the disposition of the material when removed, I was told that the bridges where they had seen portions break off were about 6 feet thick, and that the depth of water beneath was from 25 feet to 30 feet. This was inferred from the depth to which the pine trees were submerged, when they fell in perpendicularly, to wit, up to their limbs. I except the depth of water, but I think the average thickness of the bridges will probably exceed 6 feet. I believe that they can be all removed at a cost of $5,000.

It will be seen from the table that the aggregate transverse length of the bridges is 1⅛ miles, or more than 6,000 feet. I think that 3,000 feet of drilled holes, about 2 inches in diameter, and from 2½ feet to 4 feet deep, properly aligned, and well loaded above with sand or rubbish to insure the blowing down of the soffits, will cause the bridges to drop into the water beneath and dispose of them satisfactorily. My informants said that they thought the material of the bridges was limestone, but I suspect it is shale.

The basin of the Aucilla must be included among the "garden spots" of Florida. The river is the eastern boundary of Jefferson County, extending from the Gulf to the Georgia State line, and second only to Leon County in past times in wealth and productiveness. Of its present relations to other counties I cannot speak advisedly. In 1850, according to Lippincott's Gazetteer, edition of 1873, it was second only to Leon County. By the census of 1870 it was still second only to Leon County. The census of 1870 is the only source of specific information to which I could refer. * * * Madison County, on the east side, and next to Georgia, is rich. Taylor County is poor. The agricultural products of the bordering counties are cotton, both sea-island and short staple, sugar, molasses, corn, rice, &c. The "hammock lands" set in about 1¼ miles above the mouth of the river and extend 10¾ miles up, *i. e.*, 12 miles above the mouth. They are at present abundantly covered with timber of the best quality—live oak, palmetto, ash, white oak, beech, cherry, mulberry, cypress, and so on. These lands belong mostly, if not entirely, to the government. They are fertile. It is said they would be worth $50 per acre when cleared of their timber. * * * It is thought that if the bridges I have described were removed these lands would be brought into the market at once. It is self-evident that these obstructions totally submerged at high-water must raise the high-water level very considerably, to the great detriment of the public lands.

The time selected for my examination was unfortunate, as a general and heavy fresh pervaded all the rivers in this region. I could not ascend the river, but I am told that by cleaning out the logs and trees a boat carrying from 2 feet to 2½ feet draught will be able to ascend it up to the railroad. To take merely a business view of the matter, I am convinced that the removal of the bridges would be advantageous.

THE WACISSA.

This is a lake in the midst of a swamp. It formerly vented itself through the swamp by various outlets into the Aucilla. One of these was improved; that is to say, it was opened to a width of 30 feet and a depth of 3 feet. This canal, so called, is about 3 miles long, and its mouth is about 5 miles above the mouth of the Aucilla. The lake is about 10 miles long, and heads, at its northwestern extremity, against the bluffs of the rich and cultivated lands, where it is fed by numerous springs. It has an abundant depth of water; is 280 feet wide at its narrowest point, and never rises more than 2 feet above low-water. The canal is now obstructed by logs. It will require about $300 to remove them.

I am, major, with great respect, your obedient servant,

POWHATAN ROBINSON,
Assistant Engineer.

Maj. A. N. DAMRELL,
Captain, Corps of Engineers, U. S. A.

K 20.

EXAMINATION OF CHIPOLA RIVER, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., August, 26, 1881.

GENERAL: I have the honor of submitting the following report upon the examination of the Chipola River, Florida, authorized by act of Congress approved June 14, 1880, and assigned to me by letter dated June 17, 1880.

The examination extended from the road-bridge, one-half mile southeast of Mariana, the county seat of Jackson County, Florida, to its junction with the Apalachicola River.

The river was formerly navigated by steamboats and barges, transporting cotton from Mariana to Apalachicola.

The present obstruction to navigation consists in numerous shoals in the upper part of the river, and cypress timber in the lower part, but in both cases improvement can be easily made.

The estimated cost of the improvement of this river from Mariana to the Apalachicola River by the way of the Chipola cut-off, so as to render it navigable to boats 100 feet long, 20 feet beam, and 2½ to 3 feet draught, is as follows:

12,000 cubic yards of loose rock, at 50 cents	$6,000
1,000 cubic yards of solid rock, at $2	2,000
750 linear feet wing-dams, at $2	1,500
Removal of trees	5,000
Appliances, engineering, and contingencies	6,500
Total	21,000

* * * * * * *

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. HIRAM HAINES, ASSISTANT ENGINEER.

MOBILE, ALA., *March* 18, 1881.

SIR: I have the honor to submit the following report upon the examination of the Chipola River, Florida, made in pursuance with your instructions.

The Chipola River has its principal sources in Geneva and Henry counties, Alabama, and, flowing through Jackson and Calhoun counties in Florida, unites with the Apalachicola River about 35 miles above the town of Apalachicola.

The examination of the river was begun at the road-bridge, one-half a mile southeast of Mariana, the county seat of Jackson County. Here the stream is 100 feet in width and has an average depth of 4 feet at low-water, with a middle surface velocity of 160 feet per minute. For the first 5 miles it is fringed on either side with swamps or low lands, subject to overflow. Beyond the narrow strip of low land the country rises almost abruptly to an elevation of about 150 feet, spreading out with undulating surface, partly under cultivation, but mostly lying at waste or covered with an original growth of pine and oak. As we descend the stream for the next 40 miles, its margin becomes better defined; abrupt banks take the place of swamp, while the country upon either side loses its undulating character and becomes flat. There is little irregularity in the width of this part of the river, except at the islands or shoals, the increase being gradual until 150 to 200 feet is attained. A few miles below Abe Springs the river again enters a swamp, which merges into the head of Dead Lake, which is itself an overflowed cypress swamp of 1 to 2 miles in width and 15 miles long.

The current now becomes barely perceptible, and it is with considerable difficulty that the channel is distinguished from the numberless arms that make out from it, and terminate, at a greater or less distance, in impassable thickets of cypress trees or accumulations of drift. It is, however, generally deep and spacious, and occasionally approaches the main land on one side or the other, thus affording access to it for the produce of the country contiguous to the lake.

The obstructions to navigation consist in numerous shoals in the upper part of the river, the positions of which are shown in the accompanying maps, and the occasional contraction of the channel though the lake by encroachments of the cypress timber. In neither case, however, are the obstructions of a formidable character. The shoals are formed by the intersection of the stream with some of the rocky strata of the Tertiary formation, which have a dip corresponding in direction, and an inclination but slightly exceeding that of the fall of the river. Generally the rock is broken up and may be easily removed, or the shoal may be overcome by wing-dams, and, as in no case is there less than 2 feet of water in the channel through them at its lowest stage, but little work of deepening will be required for the class of boats suitable for the commerce of the river. The overhanging trees are few, owing to the nature of the banks, which in the upper part of the river are commonly supported by rocky strata, and through the swamp they are generally remote from the channel. With the exception of an assemblage of short bends about 3 miles above Abe Springs, known as "The Seven Points," and a few other isolated instances, the course of the river is straight or with easy bends, and, except at the shoals referred to, there is ample depth of water, generally, from bank to bank.

But little rectification of its alignment will therefore be necessary in this part of the river. Wherever the channel of the lake is contracted, its width may often be made ample by the removal of a single tree, and where the channel is most intricate or tortuous, the cypress growth is usually sparse, and disposed in single trees or clumps in such a manner as to admit of all desirable rectification at a small cost.

The river was formerly navigated with barges employed to transport cotton from Mariana to Apalachicola, and two small steamboats, the Farley and Jackson, were for a short time also engaged in this trade. The latter was 100 feet long and 20 feet beam, built at Pittsburgh. The barges were usually from 16 to 18 feet beam, and 80 to 100 feet in length.

The immediate commerce of the river would be chiefly obtained from Mariana and its vicinity, and consists of the ordinary products of the farm, of which cotton would be the principal item. The culture of oranges has been commenced along the borders of Dead Lake to a considerable extent, and the production of this fruit will doubtless at some future time form a commerce in this region of much importance.

It is, however, my impression that far more is to be looked for in the development of the fertile region contiguous to the upper river, which would be largely promoted by such an improvement of the river as would afford a safe and cheap means of transportation.

At present the cotton and other produce of the country is transported in wagons to the Apalachicola River, an average distance of about 30 miles, and thence to Apalachicola or Columbus by steamboat.

Upon investigation, I find that the area of cultivated lands that would be affected by an improvement of the river is about 200,000 acres, with a present population of 20,000, situated in Jackson, Washington, and Calhoun counties, Florida, and Geneva and Henry counties, Alabama. The value of produce and supplies that would seek transportation by the river is estimated to be as follows:

	Value.
10,000 bales of cotton	$500,000
Other farm products	200,000
Timber and saw-logs	100,000
Return freight	600,000
	1,400,000

This estimate, it is thought by competent opinion, would be doubled should the former production of agricultural values in this region be restored.

The following is an estimate of the cost of improving the river from Mariana to the Chipola Cut-off, so as to render it navigable throughout the year for boats 100 feet long and 20 feet beam, and 2½ to 3 feet draught. I should deem it inexpedient to make any expenditure upon either of the several channels below the junction of the lake with the cut-off, as the cut-off, which is entirely free from obstructions, gives easy access to the Apalachicola River within a distance of 2½ miles, while the work required to render navigable either of the channels connecting with the river below would exceed that of the entire river from Mariana to the cut-off. The distance from the foot of the lake to Apalachicola, by way of the cut-off, would be less than by the Chipola River, while it would, of course, be the channel of communication to all points upon the Chattahoochee and Flint rivers, and the object of the improvement would therefore be fully subserved, so far as present requirements of trade exist, by completing it to this point. The distance from Mariana to the foot of the lake by the river is about 90 miles.

ESTIMATE OF COST.

12,000 cubic yards of loose rock, at 50 cents	$6,000
1,000 cubic yards of solid rock, at $2	2,000
750 linear feet wing-dam, at $2	1,500
Removal of trees	5,000
Appliances, engineering, and contingencies	6,500
Total	21,000

Maps of the river, showing the location and extent of the shoals and the channel through Dead Lake, and also of the lower portion of the river, showing its relation to the Apalachicola River, and index map, accompany this report.

Very respectfully, your obedient servant,

HIRAM HAINES,
Assistant Engineer.

K 21.

EXAMINATION OF OCOLOCKONNEE RIVER, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., August 26, 1881.

GENERAL: I have the honor of submitting the following report upon the examination of the Ocolockonnee River, Florida, authorized by act of Congress approved June 14, 1880, and assigned to me by letter dated June 17, 1880. The examination was carried 60 miles up the river.

There was found water sufficient for a vessel with a draught of about 8 feet across the bar at the mouth of Ocolockonnee Bay, and thence through the bay into the river. From the mouth of the river (48 miles up) to Smith's Creek there is water enough for a vessel with about 4 feet draught, and from there only for 2 feet, or possibly 2½ feet, at low-water.

The obstructions to navigation are logs, snags, and overhanging trees. The cost of improvement is estimated at about $20,000 for the 60 miles.

The present commerce on the river appears to be confined to rafting logs, and is small in extent, but no approximation as to the exact amount could be obtained.

The country on this portion of the river is very poor, but the counties bordering the upper portion, above where the examination was carried —Leon and Gadsden—are rich and productive.

The report of Mr. Powhatan Robinson, who made the examination, is forwarded herewith.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. POWHATAN ROBINSON, ASSISTANT ENGINEER.

MOBILE, *January* 18, 1881.

MAJOR: In pursuance of your orders of October 22, 1880, I have made an examination of the Ocolockonnee River, with a view toward its improvement, and I now have the honor to submit the result of my observations.

* * * * * * *

A vessel can carry about 8 feet draught across the bar at the mouth of Ocolockonnee Bay, thence up the bay, by an intricate channel, to the mouth of the river, and thence, I think, for 30 miles up the river, to a place which I shall call Old River Lake. Up to this point the river is from 160 feet to 500 feet wide, more or less, perhaps. I roughly estimate the cost of improvement for navigation up to this point at $1,000. But here the river changes its character entirely. It is reduced in width to from 60 feet to 120 feet, more and less. It seems to have torn its way through swamps. * * * The channel is filled with logs, trees, and snags, and much obstructed by overhanging trees. To put it in navigable order above Old River Lake would cost, I should say, for 20 miles, at $250 per mile, $5,000. This is for the removal of snags, logs, and trees. Above this the cost would not exceed, I think, $150 per mile. The country is poor beyond expression—a mere bed of sand. The inhabitants tell me they barely make a living from year to year. * * * I had to depend mainly on my own observations for information concerning the river. The people know nothing about it; I do not think they use it at all, except for rafting, and I believe that the general mode of rafting is to turn a little raft loose somewhere, and then cut across the country and meet it somewhere below. The river is more persistently crooked than any stream that I have ever met with. I mean that it is everlastingly crooked one way or the other, and a reach of 1 mile is a rare sight. The local formula for computing distances by water is "3 miles in for 1 mile out." This is the reason that they always travel by land.

At 8 miles above the mouth, I passed the last house in sight of the river. After this I saw no human being on my entire trip of 60 miles, with the exception of a sporadic party of negroes, who passed me 20 miles above the mouth, in 2 boats loaded with potatoes, greens, &c. * * *

An occasional bluff finds its way to the water's edge, and intermediately the river at high-water spreads out over extensive swamps interspersed with lakes and lagoons. I should have mentioned that I think a boat might carry 4 feet draught up to Smith Creek, 48 miles above the mouth. Beyond this I do not think we could depend upon a depth of more than from 2 feet to 2½ feet at low-water.

Leon and Gadsden counties, bordering on the State of Georgia, and separated from each other by the river, are both rich. The Jacksonville, Pensacola and Mobile Railroad passes through them, east and west, and there is also a railroad from Tallahassee to Saint Mark's, connecting at the latter place with the Gulf. These communities are thus furnished with direct and rapid communication with their markets, affording them facilities very much superior to anything that the navigation of the Ocolockonnee River could offer.

There is an abundance of good timber on the river. An appropriation of $3,000 would be sufficient, in my judgment, to clear it out for rafting purposes alone from Old River Lake to McCall's Bridge, a distance of about 80 miles. McCall's Bridge is on the old public road between Tallahassee, Quincy, and so on. It is 15 miles by land below the railroad.

I am, major, with great respect, your obedient servant,

POWHATAN ROBINSON,
Assistant Engineer.

Maj. A. N. DAMRELL,
Captain, Corps of Engineers, U. S. A.

K 22.

EXAMINATION OF HOLMES CREEK, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., August 26, 1881.

GENERAL: I have the honor of submitting report upon the examination of Holmes Creek, Florida, provided for by act of Congress approved June 14, 1880, and assigned to me by letter dated June 17, 1880.

The examination was carried from its junction with the Choctawhatchee River to Vernon, the county seat of Washington County, about 35 miles.

The river was found to have abundant width and depth for such boats, not exceeding 100 feet in length, as would be needed to transport the produce of the adjacent country.

The obstructions to navigation are snags and overhanging trees. The estimated cost of their removal is $5,000.

Five steamers have been engaged in the trade on the river. Such statistics of the amount of commerce as could be obtained are appended. The population of the valley is about 3,000.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. HIRAM HAINES, ASSISTANT ENGINEER.

MOBILE, ALA., *December* 22, 1880.

SIR: I have the honor to submit the following report upon the examination of Holmes Creek, Florida, made in obedience to your instructions.

The examination extended from its confluence with the Choctawhatchee River to within a few miles of Vernon, the county seat of Washington County, about 35 miles, and for that distance I find the stream to possess ample capacity of volume for navigation with steamboats and barges not exceeding 100 feet in length. Its width varies from 50 feet to 300 feet, and, with the exception of a single locality, at the mouth of a cut-off from the Choctawhatchee River, below Boynton's Landing, its depth at low-water exceeds 10 feet. It is bounded on either side, almost continuously, by an overflowed cypress swamp, with an occasional bank of a few feet in height reaching its margin and serving as a landing. The bed of the creek is but little obstructed by snags, the current being slow and the adjacent timber being cypress, springing generally from a considerable depth under water; is usually erect in its growth, and presents but few obstacles in the form of inclining trees. The principal work required to admit of the passage of boats of the size stated, to Vernon, will be removing overhanging limbs, occurring at narrow parts of the stream and in the short bends.

I take occasion to remark here that in tortuous and narrow streams it is far more frequently the case that overhanging limbs in the bends obstruct the channel and embarrass the working of a boat around a point than when such obstacles occur on the point itself.

For this work I have estimated that $5,000 will be ample. The construction of a brush-dam across the cut-off referred to belongs properly to the Choctawhatchee River work, and is, therefore, not included in this estimate.

The following are the names and dimensions of steamboats that have been engaged in the commerce of this river: Bloomer, stern-wheel, 100 feet long; Magnolia, propeller, 70 feet long; Minta, side-wheel, 73 feet long; Ella May, propeller, 100 feet long; Lulu Burns, propeller, 31 feet long.

The improvement of Holmes Creek will aid materially in the development of an extremely fertile section of country, known as Holmes Valley, having a population of about 3,000, and producing largely of cotton and sirup.

Very respectfully, your obedient servant,

HIRAM HAINES,
Assistant Engineer.

Maj. A. N. DAMRELL,
Captain, Corps of Engineers, U. S. A.

STATEMENT OF THE COMMERCE OF HOLMES CREEK, FLORIDA, FOR YEAR ENDING JUNE 30, 1881, AS NEAR AS COULD BE ASCERTAINED FROM THE MERCHANTS OF THAT LOCALITY.

	Value.
450 bales cotton	$22,500
6,000 bushels potatoes	3,000
400 barrels sirup	4,800
Timber	2,000
Miscellaneous produce	5,400
Total	37,700

This statement does not embrace the values of the agricultural products of the whole region of the country contiguous to Holmes Creek, as by far the greater part of it finds transportation to market by other means. The improvement of this stream as recommended would not only largely increase its commerce, but would also have a tendency to promote the agricultural development of this the most fertile region of country in West Florida.

K 23.

EXAMINATION OF EAST BAY AND BLACKWATER RIVER, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., August 27, 1881.

GENERAL: I have the honor of submitting the following report upon the examination of East Bay and Blackwater River, Florida, authorized by act of Congress approved June 14, 1880, and assigned to me by letter dated June 17, 1880.

The examination was carried from White's Point, 9 miles east of Pensacola, to a point on the river, about 12 miles above Milton.

The principal obstructions to the navigation of the bay are a number of hard shoals or lumps in the lower part, with from 2 to 5 feet water on them, and several sand ridges in the upper part, between Escribana and Robertson's Point, with 6 feet at low-water.

The only obstruction found in the river is what is known as Hunt's Bar, a compact sand-bar, about 250 feet wide, with 6 feet of water, extending across the river one-half mile below Bagdad.

The improvement required is:

1st. The reduction of one of the lumps known as the "Beer Garden."

2d. The dredging of a channel through the sand ridges, 100 feet wide, to a depth of 9 feet at mean low-water (about 3 feet of dredging) and 2,500 feet long.

3d. The cutting of a channel of like width and depth through Hunt's Bar.

4th. Three beacons, one to be lighted.

The estimated cost of these improvements, not including the beacons, which come under the Light-House Establishment, is as follows:

Dredging, lump A, 5,000 cubic yards, at 50 cents	$2,500
Dredging on flats, 28,000 cubic yards, at 50 cents	14,000
Dredging on Hunt's Bar, 3,000 cubic yards, at 50 cents	1,500
	18,000
Engineering and contingencies	2,000
	20,000

The approximate estimate of the amount of commerce passing yearly through East Bay is:

EXPORTS.

	Value.
Lumber, 30,000,000 feet, B. M	$360,000
Sawed timber, 900,000 cubic feet	108,000
Hewed timber, 400,000 cubic feet	48,000
Sash, doors, and blinds	40,000
Wool, hides, shingles, and country produce	100,000
	656,000

IMPORTS.

	Value.
Provisions, machinery, and general merchandise	$600,000
Logs from Escambia	50,000
	0,000
Exports	6,000
Total value exports and imports	1,306,000

The following vessels make regular passages to Milton or Bagdad:

	Value.
Neptune, 600 annual passages	$25,000
Captain Sam, 200 annual passages	25,000
Juno, 150 annual passages	25,000
E. E. Simpson, 100 annual passages	25,000
Colonel R. Ingalls, 200 annual passages	6,000
Toiler, 200 annual passages	4,000
Steamers Mary Louisa, Seminole, Starlight, Santa Rosa, Mary Ida, and Hercules, plying chiefly in the lower bay, 150 passages each	60,000
Steamer Fountain, plying between Mobile and Milton, 150 passages	15,000
Schooners Ajax, Martha, L. A. Edwards, Mary E. Rushing, W. A. Watson, Mary Ellen, Sarah Hale, 150 passages	50,000
Vessels for repairs at the docks at Bagdad, varying from steamers of 600 to 700 tons, and sailing vessels from 50 to 300 tons, and in value from $3,000 to $50,000, averaging 100 annually, with a mean value of $10,000; two lumber lighters, $15,000	1,015,000
Total value of vessels	1,250,000
Exports and imports	1,306,000
	2,556.000

The town of Milton has a population, including the suburbs, of about 2,500. The population of Bagdad, including those dependent upon the mills of that place for maintenance, reaches about $1,500. These two communities have been built up and are supported mainly by the timber and lumber business.

Pensacola is the port of entry for East Bay and Blackwater River.

The report of Mr. H. Haines, who made the examination, and tracing of map illustrative of the same, is herewith forwarded.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. HIRAM HAINES, ASSISTANT ENGINEER.

MILTON, FLA., *November* 30, 1880.

SIR: In compliance with your orders, I have made an examination of East Bay and Blackwater River, Florida, my examination extending from White's Point, 9 miles east of Pensacola, to a point on the river about 12 miles above Milton.

In order to make the examination complete, I found it advisable to trace the shore lines of the bay and river from the points reached by the coast-survey chart to Milton, which is virtually the head of navigation, and take soundings on diagonals across the channel throughout that distance. The accompanying field map, and reduced copy of the same, which I have prepared during the progress of the examination, indicate the shore lines and marginal topography, the locality and contour of such shoals as it is important to mark, and their relation to the present and proposed lines for the courses of vessels navigating the bay.

The principal obstructions to the navigation of the bay and river consist in hard shoals or lumps dispersed in and along the channel of the lower part of the bay, and a number of narrow sand ridges lying interlaced across the channel of the mud flats between Escribana and Robertson's Points. There are from 2 to 5 feet of water upon the lumps, and 6 feet at extreme low-water upon the ridges. The only obstruction requiring removal in Blackwater River appears to be what is known as Hunt's Bar. This shoal extends obliquely across the channel of the river, about one-half a mile below Bagdad. It consists of compact sand, forming a ridge about 250 feet wide, with 6 feet of water upon it at low-tide. The subjoined estimate of the cost of work required to remove these obstructions shows that a small amount, comparatively to the extent of the commerce to be benefited, will be necessary.

The reduction of lump marked A, locally known as the "Beer Garden," will relieve the lower bay of its chief obstruction. At present it is not only seriously in the way, but in endeavoring to avoid it others no less dangerous are liable to be encountered. By removing an average of about 2 feet of the summit of this lump for an area of 200 by 300 feet, the entire lower part of the bay may be traversed, as shown upon the map, by a direct line from the anchorage south of White's Point to the point northwest of Escribana Point, marked as a position for a beacon light.

The work estimated for across the "Flats" consists in dredging a channel-way 100 feet wide and 3 feet deep through the ridges referred to, an aggregate length of 2,500 feet. The work on Hunt's Bar would be the cutting of a channel of like width and depth across it. The construction of any dams across the outlets from the river above this bar, for the purpose of directing the water to the channel, may, I think, be safely deferred, though some such work may ultimately be found advisable.

ESTIMATE FOR COST OF DREDGING.

Lump A, 5,000 cubic yards, at 25 cents	$1,250
On Flats, 28,000 cubic yards, at 25 cents	7,000
Hunt's Bar, 3,000 cubic yards, at 25 cents	750
	9,000
Engineering and contingencies	1,000
	10,000

* * * * * * *

The following is a statement of the amount of timber and lumber exported from Pensacola during the commercial year ending August 31, 1880:

Countries.	Hewed timber.	Sawed timber.	Lumber.
	Cubic feet.	*Cubic feet.*	*B. M. feet.*
Great Britain	3, 176, 651	3, 389, 745	17, 551, 000
Continent of Europe	565, 306	590, 568	15, 898, 000
Africa, Java, and Azores	3, 060	179, 056	504, 000
West Indies and South America	1, 848	....	13, 982, 000
Coastwise	....	....	38, 599, 000
	3, 747, 765	6, 159, 369	86, 534, 000

It is estimated by those most conversant with the subject that at least three-fourths of this commerce is brought down the Escambia and Blackwater rivers.

Very respectfully, your obedient servant,

HIRAM HAINES,
Assistant Engineer.

Maj. A. N. DAMRELL,
Captain of Engineers, U. S. A.

K 24.

EXAMINATION OF TOMBIGBEE RIVER, MISSISSIPPI, FROM FULTON TO WARREN'S MILL.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., February 10, 1882.

GENERAL: I have the honor of submitting the following report of an examination of the Tombigbee River, from Fulton to Warren's Mill, provided for by section 3 of the river and harbor act of March 3, 1881, and assigned to my charge by department letter, dated March 21, 1881.

The Tombigbee River is formed by the junction of Brown's Creek and Mackey's Creek, 25 miles by water and 11 miles by direct line above Fulton. Warren's Mill is on Mackey's Creek, 5 miles above the junction by land and 12 miles by water.

The improvement of Mackey's Creek for steamboat navigation is not practicable, on account of the narrowness of the stream and its abrupt banks.

The Tombigbee from Fulton to the junction can be improved by cutting overhanging trees, and removal of logs, stumps, and snags, for high-water navigation, so as to be as good as that portion already improved from Columbus to Fulton, at a cost of about $11,000, and the work can be done in one ordinary low-river season.

The benefit to be derived would be the saving of about $2.50 per bale on freight on about 4,000 bales of cotton annually, and corresponding reduction on return supplies of at least 80 per cent. on value of the cotton. The cotton and return supplies are now hauled over bad roads, 20 and 35 miles, to and from the Mobile and Ohio, and Memphis and Charleston railroads respectively.

The report of Mr. H. Harding, by whom the examination was made, is transmitted herewith.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. HORACE HARDING, ASSISTANT ENGINEER.

TUSCALOOSA, ALA., *November* 4, 1881.

MAJOR: I have the honor to submit the following report of an examination of the Tombigbee River from Fulton to Warren's Mill. * * * * *

The improvement of the Tombigbee for winter navigation, between Fulton and Columbus, Miss., which has been in progress for several years, is now nearly completed, and the advantages of this improvement, already sensibly felt, have, I presume, aroused a desire for its extension above Fulton.

During the past winter the steamboat Lillie Lou made regular trips to Fulton, and the river being now open to that point an improvement carried higher up would be immediately available.

The Tombigbee is formed by the junction of Brown's Creek and Mackey's Creek, 25 miles by water and 11 miles by direct line above Fulton. Warren's Mill is on Mackey's Creek, 5 miles from the junction by land and 12 miles by water.

Between Warren's Mill and the junction steamboat navigation is impracticable.

Mackey's Creek is only 25 feet wide between banks, and, owing to the abrupt bends in the creek, not all of this would be available. Navigation for small flat-boats and lumber rafts might be opened, but in that case a county bridge that crosses the Tombigbee immediately below the junction would have to be raised, and I do not think the demand for this improvement is sufficiently general to induce the county to alter the bridge. In fact, Warren's Mill, a combined saw and grist mill, is not now in operation, and I was informed has done but little for several years.

Between Walker's Bridge at the junction, and Fulton, the river is naturally as well adapted for winter navigation as it is below Fulton. It maintains its low-water width of 75 to 80 feet up to Walker's Bridge; is as luggish stream, free from rapids, shoals, or artificial obstructions of any kind.

High-water ranges from 20 feet at Fulton to 14 feet at the bridge above the summer stage, and usually remains not less than 4 feet above that stage for six months, say from the middle of November to the middle of May.

Just before my examination was made a rise of 2 feet had occurred at Columbus, which I found had been 6 feet at Fulton.

From this fact it may be inferred that whenever a steamboat could pass Columbus there would be ample water to reach the junction.

The improvement needed is simply to cut the leaning and overhanging trees on the banks, and to remove from the stream all stumps and fallen timber that show above low-water. Sycamore, gum, and water-logged timber would be hauled out and deposited on the banks. All such as is buoyant would be cut up where it lies into short lengths and left for high-water to carry away.

The estimated cost of the improvement from Fulton to the junction is as follows:

Cutting trees and removing logs and drift, 25 miles, at $400	$10,000
Outfit and quarter-boat and tools	1,000
Total	11,000

The work can be done in one ordinary low-water season.

The demand for this improvement arises from the fact that the cotton which would seek the river, if made navigable, is now hauled across Walker's Bridge to the Mobile and Ohio Railroad, a distance of 20 miles, or to the Memphis and Charleston Railroad, 35 miles from Walker's Bridge. The cost of hauling by wagons to the nearest railroad station, the roads being very bad in winter, is $1.25 per bale, and the railroad charges are $3.75, making a total cost of $5 per bale, from Walker's Bridge to Mobile. By river the cost would not exceed $2.50 per bale, a reduction of 50 per cent.

Captain Walker, who lives near Walker's Bridge, and to whom I was referred as the best authority for business statistics, estimated that 2,000 bales cotton would seek shipment by river at that point, and fully as much more would be hauled to the river, at landings between Fulton and the junction, were the river made navigable to Walker's Bridge. On this estimate there would be an annual saving of $12,000 to the community in cotton transportation, and as there would also be a saving of 20 miles in wagon transportation on goods brought up the river, as compared with hauling from railroad, the estimated saving may be considered as not overestimated. The region to be benefited by the proposed improvement is at present greatly inconvenienced in winter by the want of transportation facilities. Last winter, when cold and wet weather prevailed to an unusual extent, it was often impossible, owing to the state of roads, to haul a loaded wagon to or from the railroad, and at times a scarcity of supplies was experienced.

To avoid a recurrence of such troubles, as well as to cheapen the cost of transportation, the improvement of the river from Fulton to Walker's Bridge is urgently desired.

Very respectfully,

HORACE HARDING,
Assistant Engineer.

Maj. A. N. DAMRELL,
Captain of Engineers, U. S. A.

K 25.

EXAMINATION OF DOG ISLAND HARBOR AND CROOKED RIVER, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., February 15, 1882.

GENERAL: I have the honor of submitting herewith a report of the result of an examination of Dog Island Harbor and Crooked River, Florida, provided for by the third section of the river and harbor act of March 3, 1881.

I.—DOG ISLAND HARBOR.

This harbor is already as good a one as is needed, having a least depth of 15½ feet on the bar, at mean low-tide, and a large, deep, and commodious anchorage inside.

II.—CROOKED RIVER.

The object sought here is to deepen the channel over the bar at the mouth of the river and a short distance up the river to 13 feet, so as to connect the deep water in the river with the Dog Island Harbor. There is now a least depth of 4½ feet.

The commerce to be benefited by this improvement is the lumber trade of the town of Rio Carabelle, where there are at present two large saw-mills.

The settlement is a new one, and the shipments have barely commenced.

The prospective commerce cannot be estimated with any certainty, but should be considerable, as the supply of lumber on the Ocolockonee and New rivers is very great.

The improvement can be accomplished by dredging, and will cost about $72,000.

* * * * * * *

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

EXAMINATION OF HARBOR OF KEY WEST, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., February 16, 1882.

GENERAL: I have the honor of submitting the following report of the result of an examination of harbor of Key West, Fla., provided for by the third section of the river and harbor act of March 3, 1881.

The improvement desired is the deepening of the "northwest channel" from its present depth of 11 feet at mean low-water, which is not sufficient for present commercial purposes, to 17 feet.

The improvement can be made by dredging, and would probably be reasonably permanent. The cost of a cut 300 feet wide at top and 17 feet deep would be about $140,000.

A careful survey of the channel was made in 1868, under direction of Col. J. H. Simpson, Corps of Engineers, United States Army, whose report is contained in the Annual Report of the Chief of Engineers for 1868, pages 517 to 525.

The principal object to be gained by the improvement is in the great saving in distance for all vessels plying between Key West and the Gulf ports.

The report of Mr. T. L. Harrison, by whom the examination was made, and a map showing the locality, &c., are transmitted herewith.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. THOMAS L. HARRISON, ASSISTANT ENGINEER.

MOBILE, *January* 15, 1882.

SIR: I have the honor to submit my report upon the examination of the harbor and northwest passage at Key West, Fla.

Under your order of December 6, 1881, I proceeded to Cedar Keys, Fla., by sail, thence by steam to Key West. My first object was to ascertain what the leading citizens, pilots, and merchants desired as to the improvement of the northwest passage, and what the necessities of commerce required. I found in a letter addressed to Major-General Hancock by the collector of the port, Col. F. N. Wicker (a copy of which is herewith appended), that the great importance of the improvement of the northwest passage was fully set forth in a naval, military, and commercial point of view. This same necessity is fully presented by General Simpson, in his report to the Chief of Engineers. *Vide* Report of Chief of Engineers for 1868, pages 517 to 523.

I secured the services of a very competent pilot, his crew and sloop, and at once commenced my examination.

Upon comparison with the survey made by Lieutenant Livermore in 1868, it will be seen that no material change has taken place in the channel of the northwest passage, except at the bar, where, at mean low-water, there are now but 11 feet, showing a shoaling across the bar of 1 foot. I also found a sand-bar had formed between the bar and inner buoys, and encroaching the east side of the channel, so much so that the Morgan Steamship Line found it necessary to have a danger buoy placed on the end of the spit. This formation has been gradual, is of hard sand, and seems to have had its origin from an old wreck, which is now entirely covered with sand and mud; if any remains, could be easily removed by blasting. The nature of the bottom seems to be of compact sand and mud, or an incrustation of sand, with a substratum of rotten coral and shell, which could be readily removed by dredging. I think that the channel thus opened would be a permanent improvement.

The chart herewith submitted will show the proposed line of excavation, courses, buoys, and soundings from the outer bar into the harbor.

Key West is the most northwesterly of the Pine Islands, known as the Florida Keys, 60 miles southwest from Cape Sable, same distance from Tortugas, and 100 miles north-northeast from Havana. It is about 6 miles long and 2 broad, from 12 to 15 feet above the sea-level, of coral formation, and sandy soil.

On the southwest point is the light-house, 67 feet high, one on Sand Key, 11 miles south-southwest, and a third on the northwest passage, with numerous beacon-lights along the various entrances.

Key West is the capital town of Monroe County, Florida.

The custom-house is located at Key West. Latitude of light-house, 24° 32′ north; longitude, 81° 48′ west. Population, 1860, 2,832; 1870, 5,116; 1880 (last census), 9,890.

There are manufactured here annually about 50,000 bushels of salt, and the sponge trade is very valuable, now estimated at $60,000 to $70,000 per annum.

The chief industry is in the manufacture of cigars from Cuba tobacco, and domestic leaf raised from Cuba seed. The value of this large trade is fully shown in the subjoined statement, tabulated from the custom-house returns.

Estimated cost for dredging northwest passage at Key West to 17 feet is as follows:
Cut 5,000 feet in length.
Cut 300 feet wide.
Average depth of cut, 3¼ feet—180,555 cubic yards, at 75 cents, $135,417.

Very respectfully, your obedient servant,

THOS. L. HARRISON,
Assistant Engineer.

Maj. A. N. DAMRELL,
Captain, Corps of Engineers, U. S. A.

STATISTICS OF THE PORT OF KEY WEST, FLORIDA, YEAR ENDING DECEMBER 31, 1881.

Number of licensed cigar factories	73
Cuban leaf-tobacco consumed ....pounds..	490,758
Domestic tobacco consumed ....pounds..	362,521
Number of cigars manufactured from Cuba tobacco	19,600,000
Number of cigars manufactured from domestic tobacco	15,594,875
Number of cigars sold	32,808,300
Duties collected on Cuban leaf-tobacco	$174,439
Internal revenue collected	$196,849
Leaf-tobacco on which duties were paid ....pounds..	497,995
Value of leaf-tobacco on which duties were paid	$364,417
Exports to foreign countries	$585,605
Number of documented vessels owned in the district	150
Number of vessels entered from foreign ports	334
Number of vessels cleared for foreign ports	343
Number of vessels entered from domestic ports	124
Number of vessels cleared for domestic ports	125

F. N. WICKER,
Collector.

CUSTOM-HOUSE, KEY WEST, FLA.,
Collector's Office, January 12, 1882.

CUSTOM-HOUSE, KEY WEST, FLA.,
Collector's Office, January 25, 1878.

GENERAL: Respectfully referring to the subject mentioned in yesterday's conversation relative to the dredging out of the "northwest passage," an important entrance to the harbor of Key West, I desire in brief to invite your attention to the great benefits that would be derived by commerce if an appropriation could be procured for that purpose.

Vessels sailing from Boston, New York, Philadelphia, Baltimore, Charleston, or Savannah, and destined for New Orleans, Mobile, or Pensacola, or *vice versa*, could save a distance of nearly, if not quite, 100 miles by passing through the northwest passage, provided a sufficient depth of water could be secured.

At present vessels drawing over 100 feet are compelled to make a detour around Dry Tortugas, if passing between the points named, or in case of vessels desiring to touch at Key West while *en route* to or from the ports named, they are obliged to retrace a portion of their voyage in order to a continuance of it.

A glance at the map of this coast would at once show the distance that could be saved by deepening the channel referred to.

Hoping the matter may receive favorable notice in any report you may make after the completion of your visit to this section of the State,

I am, general, your obedient servant,

F. N. WICKER,
Collector of Customs, Port and District of Key West.

Maj. Gen. W. S. HANCOCK, U. S. A.,
Commanding Military Division of the Atlantic.

EXAMINATION OF CRYSTAL RIVER, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala, February 16, 1882.

GENERAL: I have the honor of submitting the following report of the examination of Crystal River, Florida, provided for by the third section of the river and harbor act of March 3, 1881.

The improvement desired is the dredging of the channel of entrance from the Gulf into the river.

The river is broad and deep inside, but only 10 miles long. The shoals at the mouth are extensive, and have a least depth along the channel of entrance of about 4 feet. To deepen the channel to 6 feet, which would probably be sufficient for the commerce of the place for the present, would cost about $115,000, and could be accomplished by dredging and blasting.

No reliable commercial statistics could be obtained, but information was furnished by a resident of the county that the yearly shipments amounted to about 100 bales of cotton, 50 barrels of sugar, 50 barrels of sirup, and fruit, quantity not known.

There is considerable cedar timber of fine quality sent from the river to Cedar Keys, and there is also found a large supply of palmetto of excellent quality, which makes a good piling for some constructions in water, where the teredo prevents the use of the more common wood.

The report of Mr. P. Robinson, by whom the examination was made, is transmitted herewith.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. POWHATAN ROBINSON, ASSISTANT ENGINEER.

MOBILE, ALA., *September* 30, 1881.

MAJOR: I have the honor to submit the following report of Crystal River, which I made by your orders.

Crystal River is a fine stream, broad and deep, but only 10 miles long from its mouth to its head, where it is fed by innumerable springs. It lies in a southward direction about 30 miles from Cedar Keys, to which it is tributary and where all its trade is done. There is a settlement at its head which takes the name of the river.

I found no one there who could inform me definitely as to what the applicants for an appropriation desired, but I presume it is the improvement of their channel for light-draught vessels. The present channel will only admit vessels of 4 feet draught, and is very difficult to navigate. A vessel passing out to sea without impediment from the mouth of the river would take a course west by south, but the channel follows a crooked northwesterly course for some distance, and then a crooked southwesterly course for about the same distance. These two general courses may be considered as forming two sides of a triangle of which the west by south course forms the base. The west by south course produced will now follow the natural channel. I base my estimate on a channel 6 feet deep by 100 feet wide, and to cross this first bar it must be 1,500 feet long. This will give, in round numbers, say 20,000 cubic yards, all rock, or nearly all. The west by south course from the mouth of the river follows a rather low line across the bar, giving about 1¼ to 2 feet depth at low-water. For the second bar, course south by west of channel, I computed that an excavation would be required 2 by 100 by 2,700 feet, which gives 20,000 cubic yards shell and sand.

The third and fourth bars, "Bull Slough" and "Bull Head," are openings through narrow shell reefs, and will require about 1,200 cubic yards of excavation to bring them to the standard 6 by 100 feet.

The last bar, "Bull Head," is about 2¼ miles from the mouth of the river.

Crystal River is an excellent harbor in rough weather, but no vessel would attempt to enter it in a storm.

APPROXIMATE ESTIMATE OF COST OF A CHANNEL 6 FEET DEEP BY 100 FEET WIDE.

20,000 cubic yards of rock, at $5	$100,000
20,000 cubic yards of shell and sand, at 50 cents	10,000
1,200 cubic yards of shell, at $1	1,200
	111,200

Your obedient servant,

POWHATAN ROBINSON,
Assistant Engineer.

Maj. A. N. DAMRELL,
Captain, Corps of Engineers, U. S. A.

EXAMINATION OF LA GRANGE BAYOU UP TO FREEPORT, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., October 26, 1881.

GENERAL: I have the honor of submitting the following report upon the examination of La Grange Bayou up to Freeport, Fla., provided for by act of Congress of March 3, 1881.

The bayou extends about 2 miles, in a northeasterly direction, from the north side and near the head of Choctawhatchee Bay. Into it flows Cedar Creek, a deep stream, from 90 to 160 feet wide. Freeport is situated on the creek about 1½ miles above the head of the bayou.

The commerce to be benefited by any improvement is between Freeort and Pensacola. The least depth on this route outside of the bayou is at "The Narrows," where there is 4½ feet depth of water.

The improvement desired is to deepen the channel through the bayou to the same depth as at present exists through "The Narrows," to save vessels which can pass the latter place the detention often of several days at a time they now meet with during the prevalence of northerly winds, which lower the water in the bayou.

The improvement can be made by dredging, and would, in all probability, be reasonably permanent.

The cost is estimated as follows:

Dredging 66,481 yards material, at 30 cents	$19,944 30

The amount of commerce to be benefited by the improvement at present existing is about as follows annually:

EXPORTS.	
850 bales cotton, at 10 cents per pound	$42,500
26,000 pounds wool, at 30 cents	78,000
1,000 head cattle, at $12 per head	12,000
500 head sheep, at $2 per head	1,000
650,000 feet lumber, board measure, at $11 per M	71,500
Miscellaneous	33,600
	238,600
IMPORTS.	
Merchandise	178,000
Total exports and imports	416,600

The report of Mr. H. Haines, by whom the examination was made, is inclosed herewith, and a map illustrative of same is forwarded by the same mail.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. HIRAM HAINES, ASSISTANT ENGINEER.

MOBILE, ALA., *September* 30, 1881.

SIR: In compliance with the instructions contained in your letter of June 18, I have made an examination of Bayou La Grange from its entrance to Freeport, Fla.

This bayou is situated on the north side and near the head of Choctawhatchee Bay, the bayou proper extending about 2 miles inland in a northeasterly direction. Here it is met by Cedar Creek, a deep stream from 90 to 160 feet wide, upon which the town of Freeport is situated, 1¼ miles above the head of the bayou.

The shoals of that part of Santa Rosa Sound known as "The Narrows" restrict the draught of vessels plying in Choctawhatchee Bay to 4½ feet. A depth greater than would be sufficient to afford an easy passage for vessels of that draught to Freeport would therefore be superfluous.

From Freeport to the head of the bayou there is always ample depth of water, and during ordinary high-tides there is also sufficient water through the bayou to the bay. But it frequently occurs for several days at a time that there is a prevalence of winds from the north and northeast, which greatly diminish the tides in the bayou, driving the water out and entirely preventing vessels of even less draught from reaching or leaving Freeport.

By referring to the accompanying map the location and extent of the shoal water may be observed. The line upon which the soundings are placed marks the channel through the "flats" and is the line of the deepest water. The soundings are reduced to mean low-water. The material of which the bottom is composed is an extremely soft mud, and will require in dredging an allowance of at least 2 feet for backfilling.

To improve the channel through the flats of the bayou to admit of the passage of vessels drawing 4½ feet during low-tide would require the dredging of a channel-way, allowing 2 feet for backfilling, of 100 feet wide, 3½ feet deep, 1,700 feet long, and 3 feet deep, 4,000 feet long, involving a cost as follows:

66,481 cubic yards dredging, at 30 cents	$19,944 30

The annual travel to and from Freeport is ascertained from steamboat register to be two thousand and eighty persons.

Pensacola is the port of entry for Freeport.

Very respectfully, your obedient servant,

HIRAM HAINES,
Assistant Engineer.

Maj. A. N. DAMRELL,
Captain, Corps of Engineers, U. S. A.

EXAMINATION OF MANATEE RIVER, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., February 16, 1882.

GENERAL: I have the honor of submitting the following report of the result of an examination of Manatee River, Florida, provided for by the third section of the river and harbor act of March 3, 1881.

The improvement desired is the deepening of the bar at the mouth of the river and a portion of the channel of the river, so as to give a depth of 13 feet from Tampa Bay up the river to Shaw's and McNeil's points.

There is at present a least depth of 8 feet at mean low-water, not sufficient for the class of vessels engaged in the commerce between the river and outside ports.

The improvement can be accomplished by dredging, at an estimated cost of $70,000.

The present commerce to be benefited is shown by the following statistics of products shipped from Manatee River from September 22, 1880, to July 1, 1881:

12,375 boxes of oranges, at $1.50	$18,562 50
8,500 boxes of vegetables, at $1.50	12,750 00
11,000 barrels sweet potatoes, at $1.75	19,250 00
1,600 barrels of sugar, at $25	40,000 00
1,200 barrels of sirup, at $17	20,400 00
550 bales of hides, at $50	27,500 00
	138,462 50

There are also shipped annually, about 6,000 head of cattle.

A steam saw-mill has been lately erected at a place called Palmetto, and is doing an active business.

The possible increase in the commerce cannot be estimated with any certainty.

The report by Mr. P. Robinson, by whom the examination was made, and a tracing of a map of the lower portion of the river are transmitted herewith.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. POWHATAN ROBINSON, ASSISTANT ENGINEER.

MOBILE, ALA., *September* 30, 1881.

MAJOR: I have the honor to submit to you the following report of an examination made by me in obedience to your orders of "Manatee River" in the county of Manatee, Florida.

This river empties into Tampa Bay on its southern shore, and near its mouth.

The village of Manatee, strictly so called, is situated on the southern bank of the river about 7 miles above its mouth, but the settlement is pretty nearly continuous down to the mouth, and may be considered as one, though bearing several names.

The citizens of Manatee County desire the assistance of the general government that they may be enabled to establish direct communication with their principal markets, to wit, New Orleans, Key West, Savannah, and New York. To effect this object their port must be opened to sea-going vessels.

The products on which at present they chiefly depend are mostly of a perishable character—fruits and vegetables. Under present conditions they are compelled to ship them to Cedar Keys, and thence reship them by rail or sea to their ultimate destination. And this they say often causes vexatious delays, attended with a considerable loss to the producer.

The river at ordinary low-water will admit a vessel of 8 feet draught. A 13-foot channel is needed, and it is argued with good reason that this would give a very great impetus to the influx of population and the increase of production.

In addition to the special interests of the proprietors, there are also considerations of a general character which, I think, are worthy of attention.

I have heard it asserted by sea-faring men and others, that this is about the best harbor on the Gulf coast of Florida. I am disposed to believe it, though my personal observation is very limited. It is certainly a very excellent one, and very capacious. It would seem to be good policy to provide a safe refuge for vessels caught out in the heavy storms for which this coast is noted, and there is certainly no other place for a long distance north or south which can compare with it as a harbor.

As we enter the river, the *north* channel, which appears to be the one in general use at present, hugs closely to the shoal extending seaward from "Snead's Point," which is the extreme point of the northern bank. Passing the point and still holding close to the shore, we next pass red buoy "No. 2," and then turn the easternmost point of the shoal lying between the north and south channels. Thence, a course *about* southeast by south will bring us opposite the east end of a second shoal lying north of "Shaw's Point" on the south bank of river at its mouth. A short turn to the *right* will now take us under the lee of Shaw's Point, while a slight bend to the *left* will take us past "Bishop's Point" to McNeil's Point, by which the harbor will be much improved and enlarged.

McNeil's Point is a little over 2 miles from Snead's Point by the channel. The establishment of a safe port and harbor is now fully accomplished. Passing up the river and through the fine harbor on the east of McNeil's Point, the work beyond assumes a different character, becoming much heavier as the shoals advance farther outward from the shore and the channel becomes narrower. The disposition of the material, too, will be expensive, as I think it will all have to be moved outside of the mouth of the river. Harlee's warehouse stands on a pile far out from shore, and about three-fourths of a mile below Manatee. Between them a broad bar extends entirely across the river, allowing only 5 feet draught to vessels at low-water. It is situated near the end of a bight or *cul-de-sac*, and is the present head of navigation for the Tampa line of steamships.

The work might be limited to Shaw's Point, which is the present point of shipment for cattle, but if it be extended to McNeil's Point, the extreme distance of haul will not exceed 3 miles, and outside of the mouth there is good dumping ground *everywhere*. Considering only the direction of the heaviest gales, I would have thought it best to dump to northeast of the channel buoy, but the shape of the shoals seems to indicate a tendency of the material to drift southwestwardly. I obtained no information as to the currents.

APPROXIMATE ESTIMATE FOR A 13-FOOT CHANNEL ACROSS THE BAR.

To Shaw's Point alone:	
187,730 cubic yards, at 30 cents	$56,319
To Shaw's Point and McNeil's Point:	
221,730 cubic yards, at 30 cents	66,519
To McNeil's Point alone:	
202,260 cubic yards, at 30 cents	60,678

The head of *all* navigation is about 15 miles above the mouth of the river. Light-draught boats can ply from thence to the port, and the roads from the interior to McNeil's and Shaw's points are as good as the heavy, sandy soil of this country will allow.

I am, major, with great respect, your obedient servant,

POWHATAN ROBINSON,
Assistant Engineer.

Maj. A. N. DAMRELL,
Captain, Corps of Engineers, U. S. A.

K 26.

EXAMINATION OF THE OUTLET OF HARBOR OF SHIP ISLAND.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., October 25, 1881.

GENERAL: I have the honor of submitting the following report upon the examination of the "outlet of harbor of Ship Island," provided for by act of Congress of March 3, 1881.

There was found a good channel at this locality, with a least depth of 23 feet at mean low-water and no obstruction that cannot be easily avoided.

No improvement seems to be needed, nor could any one be found who advocated any.

The outlet is used by the vessels of heavier draught loading with timber from the various mills along Mississippi Sound, particularly those at East Pascagoula, and seems to be good enough for the purpose.

The anchorage inside has from 24 to 30 feet.

A copy of report of Mr. T. L. Harrison, by whom the examination was made, is herewith inclosed.

Respectfully submitted.

A. N. DAMRELL,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. THOMAS L. HARRISON, ASSISTANT ENGINEER.

Ship Island light-house is situated in latitude 30° 12′ 54″ north, longitude 88° 57′ 56.6″ west, distant from Biloxi about 12¼ miles, and 25 miles from Pascagoula River light-house. At the west end of the island is the pass, the outlet to sea from Mississippi Sound for vessels which are loaded generally with square timber from the Pascagoula Mills, drawing over 18 feet.

After a careful examination of the various channels I find nothing less than from 23 to 24 feet over the bar, with 4 to 5 fathoms inside at mean low-water. There are no obstructions in the channel (main) which cannot be easily avoided.

I do not think that any ordinary dredge could work on the bar, as it is generally rough, and there is no refuge in case of storms, which are frequent here.

After consultation with the pilots and several prominent citizens of Biloxi, I do not think there is anything at this pass, at present, requiring improvement. They all seem satisfied with the present status of the pass, and respectfully suggest that in case of an appropriation that the amount be expended on the improvement proposed on Biloxi Bar and Harbor.

I found that the soundings did not differ materially from those on United States Coast Survey charts except in the main channel, which has, I think, deepened.

Vessels arriving here report to and clear from the deputy collector's office at East Pascagoula.

Should the Horn Island improvement be made, vessels drawing over 18 feet and less than 22 feet could load there.

The Ship Island Pass is in the Shieldsboro' collection district.

Rise and fall of tide 18 to 24 inches, according to wind. Nearest light-house is on the island, near Fort Massachusetts.

Respectfully submitted.

THOS. L. HARRISON,
Assistant Engineer.

K 27.

EXAMINATION OF HARBOR AT BILOXI, MISSISSIPPI.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., February 16, 1882.

GENERAL: I have the honor of submitting the following report of the result of an examination of harbor at Biloxi, Mississippi, provided for by the 3d section of the river and harbor act of March 3, 1881.

The improvement desired is the deepening of the channel from Mississippi Sound to the wharves at Biloxi from 4½ feet, the least depth at present, to 8 feet, at mean low-water.

The improvement can be accomplished by dredging, and a channel 150 feet wide and 8 feet deep at mean low-water obtained, for about $55,000.

The present annual commerce of Biloxi is approximately estimated as follows:

292,000 barrels of charcoal, at 22 cents	$64,240
4,800 cords of wood, at $1.33	6,000
7,300,000 feet of lumber, at $12	87,600
Wool and hides	25,000
Poultry	10,000
Oranges	2,500
Oysters, bulk and shell	25,000
Canning factory	35,000
Total exports	255,340
Imports, general merchandise	250,000
Total exports and imports	505,340

Another improvement suggested is the deepening of the channel from Biloxi into Biloxi Bay from 4 feet, present depth, to 8 feet.

This can also be accomplished by dredging, at an estimated cost of about $35,000.

I do not believe, however, that a dredged cut would be reasonably permanent, and the improvement could not be obtained by any other means at a cost commensurate with its importance.

The report of Mr. T. L. Harrison, by whom the examination was made, together with a tracing of a map of the locality, is transmitted herewith.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. THOMAS L. HARRISON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., September 15, 1881.

SIR: * * * * * * *

Biloxi is a flourishing town situated on the Mississippi Sound; latitude of light-house 30° 23′ 45″ north, longitude 88° 54′ 04″ west. It has a resident population of from 2,500 to 3,000, and summer visitors from 5,000 to 7,000, according to the health of the city of New Orleans and interior. Many New Orleans families reside here during the winter.

The commerce of the place (coupled with the wants of this large population) justifies a full appropriation for a much-needed improvement, viz, dredging a channel 100 feet wide through the bar south of the light-house to the 8-foot curve. This, as projected on the chart, I think will be a permanent improvement, as it is in line of the deepest water and with the natural flow of the course of the current.

I staked out this new channel, and it is now used by the revenue cutter and steamer Heroine, there being from 3 to 5 inches more water in it than can be found elsewhere on the bar. I was informed that frequently during the winter months the steamer has been obliged to discharge her passengers and freight from outside the bar, in small boats. The commerce of Biloxi is considerable, amounting in receipts (of provisions, dry goods, &c.) and shipments of produce (such as fish, oysters, lumber, charcoal, wood, &c.) to more than $500,000. The shipments of fish, oysters, and crabs alone last year amounted to some $65,000 to $70,000. A large fish, oyster, and fruit canning factory has recently been erected on the Back Bay of Biloxi, which is one of the many enterprises in contemplation.

* * * * * * *

The dredging as proposed will be easy work; bottom of soft material (mud and sand), with here and there a ridge of hard sand.

* * * * * * *

Dumping ground to westward, 6 to 6½ feet, three-fourths mile distant.

Rise and fall of tide 20 inches to 24 inches (according to wind), the highest observed was 2.7 feet (above low-water).

ESTIMATE FOR DREDGING THROUGH BILOXI BAR.

	Feet.
Length of canal	8,000
Breadth of canal	150
Depth to dig, say	4
(This allows 1 foot for back filling.)	
Cost per cubic yard, 25 cents.	
Excavation 177,700 cubic yards, at 25 cents	$44,425

Biloxi is in the Shieldsboro' collection district; nearest light-house at Biloxi Bar.

The channel from near the light-house east, in front of Biloxi, is about 600 yards wide, and has sufficient depth for all vessels that can come in over the bar drawing 8½ feet, with breadth of 350 to 400 yards.

The only improvement necessary here would be the establishment of a wharf line, or front, as each year encroachments are made upon the channel by extending longer wharves; * * * this abuse should be corrected, and as it is in the province of the municipal authorities to act in the matter, I think they will do so.

Deer Island Flats are situated off Points Caddie and Red Bluff (as indicated on the charts), east from Biloxi and distant about 1½ miles. The flats are of soft mud and are formed, I think, by the confluence of the waters of "Back Bay" of Biloxi and the flood-tide, which flows out easterly through Deer Island Pass. The waters of the Back Bay sweep down loaded with alluvial material, which is precipitated and deposited at the points mentioned, where they encounter the swift tidal currents setting east.

I do not think a cut through these flats is now necessary, as all the vessels plying in Back Bay and its tributaries are of shallow draught. However, I made a careful survey of them, and beg to submit the following estimate:

	Feet.
Length of canal	5,000
Width of canal	150
Depth to excavate	4
(This includes 1 foot for back filling.)	
Excavation 112,000 cubic yards, at 25 cents	$28,000

Respectfully submitted.

THOS. L. HARRISON,
Assistant Engineer.

Maj. A. N. DAMRELL,
Captain of Engineers, U. S. A.

K 28.

EXAMINATION OF HARBOR AT PASCAGOULA, MISSISSIPPI.

GENERAL: I have the honor of submitting the following report upon the examination of "harbor at Pascagoula, Mississippi."

This harbor was found to be good enough, but the object desired seems to be to so improve the pass (Horn Island) from the harbor in Mississippi Sound to the Gulf of Mexico, that vessels of heavier draught can make use of it than at present.

There is a depth of 22 feet in the harbor, and a least depth of 16½ feet at mean low-water in the pass.

If this pass is deepened to a least depth of 21 feet at mean low-water it will enable the greater part of the vessels which now are obliged to load at Ship Island to load at Horn Island, within 9 miles of their principal market, thereby avoiding a long, expensive, and dangerous towage of 25 miles, and giving a much better harbor for the purpose, as in the event of a boom of timber getting adrift in this locality, as frequently happens, it goes ashore on Horn Island and is recovered, whereas at Ship Island a great deal goes to sea and is lost.

The improvement can be made by dredging and probably would be reasonably permanent, as the pass appears to be slowly deepening from year to year, from natural causes.

The estimated cost of the work would be as follows for a channel 21 feet deep and 100 feet wide (which in my opinion should be afterwards widened to 200 feet):

Excavation of 86,000 cubic yards, at 50 cents	$43,000
The commerce to be benefited was last year, from custom-house returns, 46,247,000 feet lumber, at $15	693,705
Coastwise, estimated, 10,000,000 feet lumber, at $7	70,000
Total	763,705
And for the preceding year, from custom-house returns, 22,832,000 feet lumber, at $13	296,816
Coastwise, estimated, 5,000,000 feet lumber, at $6	30,000
Total	326,816

Other enterprises in this locality, at Scranton, East Pascagoula, and Moss Point, have greatly increased in number and capacity.

An oyster, fish, fruit, and vegetable canning factory has been established at Scranton, a glass factory at Moss Point.

Large works for creosoting piles, lumber, &c., are located at West Pascagoula, and thirteen large saw and planing mills at Moss Point, and other large saw-mills at West Pascagoula.

The report of Mr. T. L. Harrison, by whom the examination was made, is inclosed herewith, and also a tracing of a map illustrative.

A. N. DAMRELL,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. THOMAS L. HARRISON, ASSISTANT ENGINEER.

Horn Island is situated 9 miles from the mouth of Pascagoula River, bearing from the Pascagoula River light-house, by compass, south by east three-fourths east; latitude of light-house, 30° 13′ 45″ north; longitude, 88° 30′ 56″ west.

It forms an elongated crescent, and this pass (which is between the east end of Horn Island and west end of Petit Bois Island) is the outlet to sea for all vessels which come to Pascagoula to load. The north side of Horn Island affords a "snug" harbor for shipping, with good holding-ground in 3¼ fathoms water; consequently a very safe place for loading lumber, timber, &c.

The chief desire of the mill men and timber merchants is to obtain 21 to 22 feet through this pass at mean low-water, thus enabling vessels drawing more than 17 to 18 feet to come in and load, and saving the cost of a long, expensive, and dangerous tow to Ship Island, where vessels drawing more than 17 to 18 feet are now obliged to load.

The distance from Pascagoula River light-house to Ship Island, by compass course, is about 25 miles.

In the event of a boom of timber getting adrift at Horn Island it floats on the North Beach, and is readily recovered.

* * * * * * *

The commerce of the port is increasing every year and now justifies a speedy improvement of Horn Island Pass and the upper river (the appropriation now being applied to the improvement of the mouth of the river, being ample to perfect that work).

A short dumping ground (say one-half mile distant from the line of dredging) can be obtained. Soft digging through the Horn Island Pass, of blue mud and sand, mixed; on the outer bar, about 60 to 100 feet wide, hard sand.

Rise and fall of tide from 20 inches to 24 inches, according to the wind.

In case of bad weather the dredge-boat and outfit could safely, by a short tow, have a safe anchorage on the north side of Horn Island.

A petition from private parties has been made to erect a ballast crib, to the westward of the present anchorage, on the north side of Horn Island.

This would be a great improvement on the present system of discharging ballast, and every facility should be granted these parties for erecting such a work, as doubtless many tons of ballast are thrown overboard in the sound, and to the detriment of navigation. Penalties and fines would be imposed if the offenders could be detected.

ESTIMATE FOR DREDGING AT HORN ISLAND PASS.

Length 6,200 feet; width 100 feet; depth, including 1 foot for back-filling, 3¼ feet.

Excavation, 86,000 cubic yards, at 50 cents	$43,000

Horn Island Pass is in the Shieldsborough collection district, but all vessels loading at this pass or at Ship Island report and clear from the custom-house at East Pascagoula. Pascagoula has a deputy collector; nearest light-house is on east end of Horn Island.

The annexed chart will show the proposed line of dredging, which is in line of best water and natural flow of current and covers the courses followed by all the Horn Island pilots.

Respectfully submitted.

Your obedient servant,

THOS. L. HARRISON,
Assistant Engineer.

K 29.

EXAMINATION OF OLD TOWN CREEK, MISSISSIPPI.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., February 11, 1882.

GENERAL: I have the honor of submitting the following report of an examination of Old Town Creek, provided for by the third section of the river and harbor act of March 3, 1881, and assigned to my charge by department letter, dated May 2, 1881.

The creek cannot be improved for low-water navigation.

For high-water navigation, from about December 1 to May 1, it can be put in good boating condition from its mouth up to City Point, 4 miles from Verona, on the Mobile and Ohio Railroad, a distance of about 30 miles by the creek and 12 miles by land, by the removal of overhanging and fallen trees and drift accumulated, at an estimated cost of about $10,000 and in one good working season.

The immediate benefit to be derived would be a saving in freight of about $1.50 each on about 34,000 bales of cotton, annually, which is now transported by rail, and a corresponding reduction in freight on return supplies of probably 80 per cent. in value of the cotton.

The creek was navigated during the high-water season, prior to the construction of the Mobile and Ohio Railroad, by steamers as high up as Comargo, 16 miles from the mouth, and one steamer ascended in 1852 or 1853 within 2 miles of City Point.

This creek is one of the main tributaries of the Upper Tombigbee, and enters it 1½ miles above Cotton Gin Port, in Monroe County, Mississippi.

The report of Mr. H. Harding, by whom the examination was made, is transmitted herewith.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. HORACE HARDING, ASSISTANT ENGINEER.

TUSCALOOSA, ALA., *November* 3, 1881.

MAJOR: In accordance with orders from you, I completed an examination of "Old Town Creek," and have the honor to submit the following report thereon:

Old Town Creek is one of the main prongs of the Tombigbee, uniting with that stream 1½ miles above Cotton Gin Port, in Monroe County, Mississippi.

The examination extended to City Point, 4 miles from Verona, on the Mobile and Ohio Railroad, and estimated to be 30 miles from the mouth by the meanders of the stream, though only 12 miles in a direct line.

Before the construction of the Mobile and Ohio Railroad, Old Town Creek was navigated to Camargo, 16 miles from the mouth, and in 1852 or 1853 a steamboat ascended to within 2 miles of City Point and took out 500 bales of cotton.

After the opening of the railroad the navigation of the creek was neglected, and from the unchecked growth of leaning timber and the accumulation of fallen trees it became impracticable.

It is now claimed that the business interests of the community require the reopening of Old Town Creek, and in support of this claim the following statements were given me:

Lee County, which is mainly interested in the proposed improvement, was organized in 1867, with a population estimated at 12,000. This had increased to 20,594 in 1880.

The cotton shipments from railroad stations within the county have increased from 10,000 bales in 1867 to 34,000 in 1880. Of this last amount 14,000 bales were raised in Lee, the remainder being drawn from neighboring counties.

The railroad being the only transportation route now open, charges are high, being $3.75 per bale.

It is in order to reduce this high rate by opening a competing route, that the improvement is mainly desired.

By river, the freight rate, with insurance and storage, would not exceed $2.25 per bale, a reduction of $1.50, which, applied to 34,000 bales, would make an annual saving to the community of $50,000.

There would also be a reduction in rates on goods brought up the river, which would consist principally of cotton bagging and ties, sugar, coffee, molasses, and fertilizers.

On the supposition that the railroad, by reducing rates, would retain all the business that is most conveniently served by it, there would remain to be transported by river an amount variously estimated at from 5,000 to 8,000 bales of cotton, which at present has to cross Old Town Creek in order to reach the railroad. The roads across the creek bottom are so bad in winter (when cotton is marketed) that often only a single bale is hauled by a four-mule team. Hence, all cotton raised east of the creek would take river transportation were it available. Directly, therefore, by affording a more convenient and accessible route to market, as well as indirectly by securing the advantages of competition, the proposed improvement would greatly benefit the community, and it only remains to consider the practicability and cost of such improvement.

Low water navigation in Old Town Creek is impracticable. I suppose a box-drain 12 inches square would readily pass all the water that was flowing in the creek when I saw it. But the banks are from 60 to 80 feet wide at the base, 100 to 125 at the surface, and 10 to 15 feet high, and after the winter rains have set in, generally from December 1 to May 1, the creek is from 6 to 18 feet above low water.

There are no shoals or rapids in the stream, and no artificial obstructions, except a bridge 6 miles below City Point.

This bridge, the president of the county board of commissioners informed me, would be converted into a draw-bridge by the county if the creek should be made navigable.

The removal of fallen timber and drift accumulations could be easily and cheaply done, as in dry weather, at low-water, a large proportion could be burned.

The leaning and overhanging trees, being mainly the growth of the last twenty years, are mostly of moderate size, and I estimate that the whole improvement could be made at a cost of $300 per mile.

To this should be added the cost of a suitable working outfit, which, consisting of a light quarter-boat, provided with blocks, ropes, and tools, could be furnished for not exceeding $1,000.

The estimated cost of the improvement would therefore be as follows:

30 miles, at $300	$9,000
Outfit	1,000
	10,000

I think the improvement could be completed in one season, if it could be commenced as early as June 1.

Very respectfully,

HORACE HARDING,
Assistant Engineer.

Major A. N. DAMRELL,
Captain of Engineers, U. S. A.

APPENDIX L.

INSPECTION OF THE IMPROVEMENT AT THE SOUTH PASS OF THE MISSISSIPPI RIVER,

REPORT OF CAPTAIN WILLIAM H. HEUER, CORPS OF ENGINEERS, INSPECTING OFFICER, FOR THE FISCAL YEAR ENDING JUNE 30, 1882.

OFFICE UNITED STATES ENGINEERS,
New Orleans, La., July 27, 1882.

GENERAL: I have the honor to transmit the annual report of the progress of the work on the improvement of the South Pass of the Mississippi River.

Mr. C. Donovan, assistant engineer, has been in local charge of the work of examinations and surveys at the pass during the year, and in his report accompanying this will be found details of all changes which have occurred there.

During the entire year there has been a channel having a least depth of 30 feet of water in it between the jetties and extending to deeper water in the Gulf. The least width of this channel was 20 feet, its greatest width was 340 feet, while its average width was about 105 feet.

The 26-foot-deep channel had a least width of 200 feet in the jetties and extending into the Gulf, except for a few days during the year, when there was a deficiency in width beyond the jetties, occasioned by a small mud lump coming up into the channel, having over its top for a few days a depth of 24 feet of water. This has since been dredged down to a depth of 29.8 feet. There was also a slight deficiency in width of this channel for five days right between the outer ends of the jetties.

In the South Pass there has been a channel 26 feet in depth, whose least width anywhere was 50 feet. In fact the channel in the pass has gradually improved, and now in its 10 miles of length there is a 30-foot channel except for about 1.2 miles in length.

The dredge-boat Bayley was dredging at the channel in and beyond the jetties for eighty-seven days, of which fifty-one days were devoted to the channel in the Gulf and thirty-four days to that within the jetties. The other two days' dredging was in the pass proper.

No additional work was done at the Head of the Passes. Near Bayou Grande an extension 95 feet in length was made to the lattice dam, and at Picayune Bayou a dam made of piles, lattice work, and brush 166 feet long was built.

To the jetties proper some little masonry work was added, and a few wing-dams and 16 cribs were placed in position, mainly for the protection of the jetties and the land accretions outside of them.

A little settling yet occurs to the jetties, and during the year it has averaged about 3 inches.

Near the shore ends of the jetties low levees of plank, brush, and ballast were built, aggregating nearly a mile in length.

Our surveys near the Head of the Passes show a deepening of 6 feet in Pass à L'outre since 1875. The shoal area between this pass and South Pass is gradually extending up river. The details of these changes, as well as others in this vicinity, are well shown on chart No. 7.

Between the jetties the channel has varied more in width than in depth. The table on page 25 of Mr. Donovan's report shows the detailed changes. A deep hole, which formerly had a depth of 40 feet of water in it, and which now has a depth of 98 feet, is forming between the jetties and about two-thirds of a mile below their shore ends.

About 800 feet out into the Gulf, and nearly on the prolongation of the west jetty, a small mud lump has formed, and now shows its top just above the surface of the water.

The surveys were this year extended out into the Gulf 7 miles beyond the outer ends of the jetties, or until a depth of 300 feet of water was found, with a view to note changes which had occurred over this area since 1876. The changes are marked, and show where much of the river sediment has lodged.

In the fan-shaped area, extending about 1 mile beyond the jetties, and covering about 1¼ square miles of area, the average amount of deposit or shoaling was 1.30 feet in height. On diagram No. 1 of Mr. Donovan's report, page 34, it will be seen that in two of the large subdivisions in the prolongation of the axis of the jetties there has been a deposit exceeding 3 feet in height; other but smaller subdivisions on both sides of this line show both a scour and fill, but the quantity of scour as compared with the fill is very small. Since 1876 the fill over the fan-shaped area here referred to has amounted to 4.72 feet in average vertical height.

The diagram on page 31 is well worthy of study, and shows graphically the movement of the curves of different depths from 1877 to the present time. Plates I and II show this movement more in detail. Unless the diagram and plates are carefully studied, they are apt to mislead, but when understood they are the most valuable and instructive part of the report.

On chart No. 3 is found a comparison by profiles of the surveys of 1876, 1879, and 1882.

Some of the results are anomalous and are not understood, as in some instances the profiles of 1882 show a deepening between the 200 and 300 feet of depths, in some places amounting to 30 feet, and some of these deepenings extend over considerable distances.

So far as the survey of 1882 is concerned, I can only say that it was carefully made under extremely favorable conditions, having had calm weather, smooth sea, good angles, three simultaneous instrumental observations to nearly every sounding, besides running on well-defined ranges, and it was made by the same experienced parties as were engaged in all our surveys.

A few surface current observations were made in the jetties and out in the Gulf with a view to ascertain the difference of velocities of the current in the jetties where the river may be said to be walled up and in the Gulf where the river has a chance to spread. The results are shown on Chart No. 7; they are far from uniform, and are unsatisfactory. When combined and compared, they show about 10 per cent. less velocity at 1 mile distant than in the jetties.

My acknowledgments are due Messrs. Donovan and Raymond and their assistants at the jetties for valuable and efficient services rendered during the year.

ESTIMATE OF FUNDS REQUIRED FOR EXAMINATIONS AND SURVEYS AT SOUTH PASS OF THE MISSISSIPPI RIVER, DURING THE FISCAL YEAR ENDING JUNE 30, 1884.

2 assistant engineers	$3,925
1 recorder	1,080
1 clerk	900
1 steam engineer	1,200
1 water-level observer	120
6 seamen	4,740
Rent of office	180
Rent of assistant engineer's quarters	240
Mileage and traveling expenses	150
Fuel for launches	600
Repairs to launches and boats	1,200
Materials and supplies for launches	500
Stationery and supplies for office	200
Contingencies	2,000
Total	17,035

Money statement.

July 1, 1881, amount available	$22,296 34
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	16,043 15
July 1, 1882, amount available	6,253 19
Amount appropriated by act passed August 2, 1882	10,000 00
Amount available for fiscal year ending June 30, 1883	16,253 19
Amount that can be profitably expended in fiscal year ending June 30, 1884.	10,000 00

Respectfully submitted.

W. H. HEUER,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. C. DONOVAN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Port Eads, La., July 21, 1882.

SIR: I have the honor to report the present condition of the works constructed by Mr. James B. Eads, for the improvement of South Pass of the Mississippi, and also the amount and character of the work done during the fiscal year ending June 30, 1882. The results of examinations and surveys made during the year are given herein, and comparisons with earlier results presented, so that the effect of the works upon the channel from the main river above the Head of the Passes through South Pass and into the Gulf of Mexico for a distance of 7 miles from the ends of the jetties may be followed.

The following charts and plates of diagrams accompany this report:

No. 1. Chart of channel from opposite South Pass light-house to the end of the jetties.
No. 2. Chart of a part of the Gulf of Mexico, showing depths out to 100 feet.
No. 3. Chart of a part of the Gulf of Mexico, showing depths out to 300 feet.
No. 4. Chart of South Pass, from South Pass light-house to Bayou Grande.
No. 5. Chart of South Pass, from Bayou Grande to the Head of Passes.
No. 6. Chart of the Head of Passes.
No. 7. Chart showing various sections, plans, &c.
Plate I. Diagrams, showing changes in the Gulf.
Plate II. Diagrams, showing changes in the Gulf from 1876 to 1882.

AT THE HEAD OF THE PASSES.

No work has been done at this point during the year, nor, in fact, since July, 1879. The condition of the works is unchanged from what was reported in connection with them in my last annual report. By reference to Chart No. 6, it will be seen that with the exception of portions of west T-head, east T-head extension, and upper dam, the works at this point are entirely buried by the deposits which they have caused to accumulate. The mattress work in the portions mentioned continues to settle and is all below average flood-tide, while the piles and other wood-work above the surface of the water are badly decayed. The depth of water through the breaks in east T-head extension and upper dam has not increased during the year, from the fact that the foundation mattresses are in place, in every case, and while the depth of water just below the upper dam, caused by the overfall, is from 20 to 40 feet, yet a channel of greater depth than 8 feet cannot be traced from these breaks into either pass. The channel into South Pass has continued to deepen and the desired shoaling above upper dam has increased.

The depth of water over west T-head, above its junction with the shoal formed to the westward of it, is from 1 to 4 feet, and while deep water runs close to this structure on the channel side, with apparent liability of undermining it, still it has thus far been undisturbed and the foundation mattresses maintain their original positions.

Mattress-sills across Southwest and Northeast Passes.—The western 1,000 feet of the sill across Southwest Pass has settled about 2 feet during the year. Mattresses are in place throughout the entire length of the sill, as is ascertained in making soundings thereon; the fact that there is deeper water on either side of the sill than in the locality where it was placed also indicates that the mattresses are still in place.

The sill across Northeast Pass is still in place and indicates no settlement during the year.

IN SOUTH PASS ITSELF.

The extension of 95 feet in length of lattice-dam which was added to the old dam near the head of Bayou Grande last year was washed away in July and August and rebuilt in October; with this exception no work has been done in the pass proper during the year. The lattice-dams which were built last year, and are fully described in my last report (see page 1247 Appendix L of the Report of the Chief of Engineers for 1881), are still in place and in good condition, except 30 feet in length of the outer end of No. 1 above Goat Island, which has been washed away. In rebuilding the above-mentioned extension to the dam near the head of Bayou Grande the following material was used: 18 piles, 5,760 feet B. M. scantling, 120 linear feet 6 by 12 inch waling streak, 2,000 carriage-bolts, and 125 feet of ¾-inch chain, the latter connecting the outer pile in the dam with another further upstream, to give greater stability.

DAM ACROSS BAYOU GRANDE.

This dam has undergone no change since last reported upon, June 30, 1881, and is in fair condition, its upper surface being from 3 to 4 feet below average flood-tide.

The depth of water through the bayou has increased 1¼ feet during the year, and now averages 6 feet and is quite uniform, while the bayou is decreasing in width.

DAM ACROSS PICAYUNE BAYOU.

During the month of August a new dam was built across this outlet, which leaves the pass at a locality five-eighths of a mile above South Pass light-house. Six years ago a dam was built 100 feet below the present one, but it had deteriorated to such an extent as to be of little value in stopping the flow through this bayou. The present dam is 166 feet long and consists of two rows of piles 8 feet apart, with nine piles in each row, connected by waling-pieces extending from shore to shore. Between the piles and resting against them are placed lattice-aprons made of 2 by 6 inch scantlings crossing each other at right angles; they are 2 feet apart from center to center, and are fastened together by carriage-bolts. The space between the two lattice-dams thus formed was then filled with loose willows, which were ballasted with stone near the shore ends of the dam, and with gravel in the center. A section of this dam, which has effectually closed the bayou, is shown on Chart No. 7. In its construction 18 piles, 2,520 feet B. M. scantling, 157 cords of willows, 57 cubic yards of stone, 248 cubic yards of gravel, and 314 bolts were used.

AT THE MOUTH OF SOUTH PASS.

Aside from a small amount of masonry no work has been done on the jetties proper during the year; wing-dams have been built and other work done to improve and maintain the channel "through the jetties," but with the exception of a few cribs it has been mostly of a temporary character.

EAST JETTY.

Crib-work.—During the year sixteen cribs built of palmetto piles have been placed as follows: Five spur-cribs (Nos. 82, 83, 84, 85, and 86) on the sea side of the east jetty, between Stations 66 and 71, to strengthen and protect the concrete wall in this locality. Three (Nos. 87, 88, and 93) were placed on the sea slope of base-line reef; three (Nos. 47, 48, and 94) forming a wing-dam at Station 112, west jetty; three (Nos. 95, 96, and 97) forming a wing dam at Station 112, east jetty, and two (Nos. 98 and 99) forming a wing-dam at the outer end of the west jetty. These cribs are built in precisely the same manner as similar ones, the construction of which is fully described in a previous report. (See Appendix L, page 1124, of Report of the Chief of Engineers for 1880.) The cribs placed on base-line reef to prevent its further recession have not been effectual in that respect, as by reference to Chart No. 1 it will be seen that the reef has receded from them, or, rather, has been washing away since joining the new land formation above it. Three courses of palmetto piles were added to these cribs after they had settled somewhat, and their upper surface is now 2.5 feet above average flood-tide; they prevent the reef from changing its junction with the jetty, and thereby prevent sand from being thrown over the jetty into the channel. The upper surfaces of other cribs mentioned are at average flood-tide.

On Chart No. 7 is given a plan showing the total number of cribs in place June 30, 1882, and their location.

The following table gives the dimensions, character, location, &c., of each crib placed during the year, and the total amount of material in all that have been built since this work was commenced. The number of each crib corresponding to that given in the table will be found on the plan above referred to.

Table giving dimensions, character, and location of cribs used during the fiscal year, and also the total amount of this work used in all constructions.

Number of crib.	Month when sunk.	Description.	Dimensions.	Number of feet palmetto.	Number of feet cypress.	Number of feet pine.	Number of feet plank.	Location.
			Feet.					
	Total as reported up to June 30, 1881.			71,913	12,262	10,371	5,071	
	1881.							
82	July	Spur palmetto	17×10×4 and 1*	136				Station 70+15, sea side, east jetty.
83	...do	do	17×10×4 and 1	136				Station 69+15, sea side, east jetty.
84	...do	do	17×10×4 and 1	136				Station 68+15, sea side, east jetty.
85	...do	do	17×10×4 and 1	136				Station 67+17, sea side, east jetty.
86	...do	do	17×10×3 and 1	136				Station 66+20, sea side, east jetty.
87	August	Palmetto	77×15×4	2,094			135	Sea slope, base-line reef.
88	...do	do	71×16×4	1,696			135	Sea slope, base-line reef.
93	September	do	75×15×6	2,432				Sea slope, base-line reef.
94	December	do	77×18×6	4,653	147			Station 111+40, river side, west jetty.
48	...do	do	40×21×10 and 8	2,770	846			Station 111+40, river side, west jetty.
	1882							
95	February	do	65×13×8 and 3	3,111				Station 111+70, river side, east jetty.
47	...do	do	41×20×19 and 11	4,910	840			Station 111+40 river side, west jetty.
96	March	do	74×15×7	2,805				Station 111+70, river side, east jetty.
97	April	do	36×16×13 and 6	2,134	32			Station 111+70, river side, east jetty.
98	May	do	86×16×13 and 5	5,476				River side, end west jetty.
99	...do	do	62×20×17×14 and 11	5,813	316			River side, end west jetty.
	Additional courses on 4 cribs			1,811				Sea slope, base-line reef.
	Totals up to June 30, 1882			112,298	14,443	10,371	5,341	
	Totals during the year ending June 30, 1882			40,385	2,181		270	

* When cribs are not uniform in height this dimension at each end is given. In sinking and ballasting these 16 cribs 1,623 cubic yards of stone were used, which was taken off either jetty, but mostly from the west one.

Masonry.—During the months of July and August, 1881, 220 linear feet of rubble parapet wall was built, and 110 feet which was partially built last year was completed between Stations 87 + 20 and 90 + 50. The average dimensions of this portion is 3 by 2.4 feet, and contains 68 cubic yards of masonry. Five blocks of masonry consisting of rubble-stone laid in cement mortar were built upon the spur-cribs between Stations 66 and 71, and two were built for a similar purpose upon a sand foundation at Stations 64 and 65. The average dimensions of these blocks are 13 by 4 by 4.3 feet, and they contain a total of 62 cubic yards of masonry.

With slight exceptions, the masonry throughout this jetty is in good condition, and its settlement, as shown by the following table, has been very slight during the year.

The number of linear feet and character of masonry in place June 30, 1882, is represented on Chart No. 1, and explained in a note thereon.

The following table gives the elevation of the top of the parapet wall, above average flood-tide, according to levels taken at various dates, at points 100 feet apart; it also gives the subsidence during the year and since the wall was built.

Table giving elevation referred to average flood-tide, and total subsidence of masonry wall on east jetty.

Location.	Date when built.	Elevation in feet.					Total subsidence.		Remarks.
		1881.			1882.				
		June 15.	August 19.	December 2.	March 16.	June 19.	Since June, 1881.	Since wall was built.	
Station.	1881.								
63 + 20	June........	4.35	4.26	4.23	4.21	4.20	0.15	0.15	Parapet wall from Station 63 + 20 to Station 101 + 79 is built of rubble-stone laid in cement.
64 + 25	May........	4.21	4.18	4 15	4.10	4.08	0.13	0.13	
	1880.								
65 + 15	April.......	4.26	4.18	4.06	4.04	4.03	0.23	0.58	
66 + 15	....do.......	4.40	4.37	4.33	4.30	4.27	0.13	0.40	
67 + 15	...do	4.30	4.27	4.25	4.19	4.18	0.12	0.40	
68 + 15	....do.......	4.27	4.23	4.21	4.15	4.15	0.12	0.62	
69 + 15	... do	4.36	4.31	4.28	4.23	4.21	0.15	0.39	
70 + 15	... do	4.34	4.32	4.28	4.21	4.22	0.12	0.38	
71 + 15	....do.......	4.30	4.27	4.25	4.19	4.18	0.12	0.54	
72 + 15	....do......	4.34	4.31	4.30	4.25	4.24	0.10	0.37	
73 + 15	May........	4.33	4.32	4.27	4.22	4.22	0.11	0.42	
74 + 15	....do.......	4.55	4.52	4.49	4.42	4.42	0.13	0.21	
75 + 15	....do.......	4.31	4.29	4.24	4 19	4.16	0.15	0.43	
76 + 15	....do	4.31	4.29	4.19	4.13	4.10	0.21	0.57	
77 + 15	....do.......	4.47	4.43	4.38	4 32	4.28	0.19	0.42	
78 + 15	... do.......	4.30	4.25	4.21	4.16	4.11	0.19	0.54	
79 + 15	....do.......	4.35	4.34	4.29	4.23	4.19	0.16	0.51	
80 + 15	....do.......	4.07	4.03	3.96	3.89	3.86	0.21	0.63	
81 + 15	April.......	3.86	3.84	3.82	3.77	3.74	0.12	0.65	
82 + 15	....do.......	4.20	4.18	4.13	4.07	4.05	0.15	0.51	
83 + 15	... do.......	4.20	4.18	4.14	4.08	4.07	0.13	0.46	
84 + 15	....do.......	4.00	3 94	3.82	3.72	3.65	0.35	0.94	
85 + 15	... do	4.12	4.10	3.84	3.65	3.61	0 51	1.02	
86 + 15	... do.......	3.86	3.83	3.67	3.52	3.35	0.51	1 25	
87 + 15	June........	3.99	3.90	3.63	3.50	3.40	0.59	1.19	
88	July..............		3.91	3.82	3.62	3 54	......	0.37	
89	.. do..............		3.84	3.72	3.58	3.54	......	0.30	
90	... do..............		3.78	3.69	3.51	3.42	......	0.36	
91	....do.......	3.97	3.94	3.78	3.41	3.32	0.65	1.17	
92	....do.......	3.87	3.82	3.58	3.37	3.20	0.67	1.50	
93	....do.	4.05	4.03	3.95	3.89	3.85	0.20	0.92	
94	....do.......	4.34	4.31	4.22	4.16	4 14	0.20	0.52	
95	....do.......	4.12	4.07	3.94	3.85	3.81	0.31	0.81	
96	June.......	3.98	4.02	3.88	3.72	3.64	0.34	0.96	
97	March	4.04	3.96	3.79	3.68	3.60	0.44	0.93	
98	....do.	3.93	3.84	3.68	3.37	3.30	0.63	1.21	
99	February ...	3.58	3.46	3.30	3.21	3.08	0.50	1.27	
100	....do.......	3.97	3 88	3.69	3.61	3.51	0.46	1.03	
101	January ..	4.01	3.90	3.77	3.69	3.61	0.40	1.03	
101 + 79	... do.......	4.03	3.90	3.70	3.62	3.53	0.50	0.98	
103	June........	4.96	4.88	4.69	4.63	4.54	0.42	0.71	Parapet wall from Station 102 + 15 to Station 116 + 33 is built of concrete.
104	....do.......	4.75	4.67	4.53	4.50	4.44	0.31	0.75	
105	.. do.......	4.90	4 82	4.65	4.61	4.56	0.34	0.82	
106	March......	4.96	4.88	4.70	4.67	4.59	0.37	0.81	
107	....do.......	4.92	4.82	4.61	4 58	4.50	0.42	0.93	
108	....do.......	4.85	4.74	4.54	4.50	4.41	0.44	1.08	

Table giving elevation referred to average flood-tide, &c.—Continued.

Location.	Date when built.	Elevation in feet.					Total subsidence.		Remarks.
		1881.			1882.				
		June 15.	August 19.	December 2.	March 16.	June 10.	Since June, 1881.	Since wall was built.	
109	....do	4.74	4.64	4.44	4.40	4.28	0.46	1.08	
110	April	4.81	4.66	4.39	4.32	4.19	0.62	1.37	
111	.... do	5.03	4.90	4.67	4.51	4.47	0.56	1.29	
112	....do	5.23	5.13	4.92	4.87	4.73	0.50	1.18	
113	....do	5.40	5.37	5.15	5.09	4.96	0.44	1.19	
114	....do	5.79	5.62	5.51	5.46	5.32	0.47	1.20	Parapet wall at Station 114 was raised 0.3 feet by plastering in September, 1880.
115	....do	6.18	6.09	5.91	5.85	5.69	0.49	0.94	
115 + 90	June........	6.31	6.22	5.99	5.93	5.78	0.53	1.03	
116 + 60	....do	2.82	2.72	2.48	2.40	2.25	0.57	1.33	From Station 116 + 33 to 117 + 78 there is no parapet. Levels were taken on foundation blocks.
117 + 08	....do	2.74	2.67	2.43	2.33	2.15	0.59	1.43	
117 + 52	....do	2.09	1.97	1.56	1.35	1.18	0.91	1.92	
Average subsidence....................................							0.35	0.81	
Greatest subsidence (at Station 117+52 last block, end of jetty)................................							0.91	1.92	

Miscellaneous work.—During the year 108 cords of willows were placed upon the east jetty at different sections between Stations 31 and 50, to bring its surface at these points above average flood-tide. The total distance covered in this way is 535 feet. Thirty-six cubic yards of gravel were placed on the river side of the concrete blocks near Station 65, to prevent the escape of water under them.

In order to secure the channel against the loss of a certain volume of water which was escaping, or would escape over the jetties, in consequence of the removal of a large quantity of stone from them, a so-called levee was built on the sea side of the jetty, at localities where it was low or where the stone was to be removed. As previously stated, the stone removed was used in ballasting cribs. An aggregate of 1,813 feet in length of such levee has been built along the east jetty, as follows: 200 feet in length, to close a bayou at Station 33; 213 feet to close a bayou at Station 42, and from Station 44 it was made continuous for a distance of 1,400 feet to intersect base-line reef.

This levee is built parallel to the jetty and about 50 feet from its center line, except the last 450 feet in length, which varies in distance from the jetty from 50 to 140 feet. It is constructed by first driving large stakes, to which are nailed planks, taken from old coal barges, thus making what might be called a tight board fence, the top of which is about 2 feet above average flood-tide; against this fence, and for a distance of 4 feet from it, loose willows are placed and ballasted with gravel. The location of this levee is shown on Chart No. 1, and in its construction 280 cords of willows and 622 cubic yards of gravel were used.

WEST JETTY.

During the month of July willows were placed on the main jetty over a length of 130 feet, commencing at Kipp Dam, and also over a length of 170 feet, commencing 500 feet below this dam. From this point to 2,700 feet below Kipp Dam a levee was built at places to close small bayous which were making through the new land formation back of the jetty by water escaping over it. From 2,700 feet below Kipp Dam down to Pelican Reef this levee is built continuously for a length of 2,125 feet, generally parallel to the jetty and from 30 to 50 feet from it. This levee is built the same as that described in connection with the east jetty, and since its completion much of the stone on the jetty adjacent to it has been removed. The total length of levee built along the west jetty is 2,550 feet, and in its construction 343 cords of willows and 911 cubic yards of gravel were used. The location of this work is shown on Chart No. 1, from an inspection of which it seems evident that the main jetties above base-line and Pelican reefs will require but little attention in future, so rapidly are they becoming buried by deposits on either side of them.

The concrete work on the west jetty remains in good condition, having settled but little during the year, as will be seen from the following table, which gives in detail information regarding their settlement:

Tables giving elevation of concrete blocks, at various dates, above the plane of average flood-tide, and the total subsidence of each block from the date of the first observation and also during the year.

WEST JETTY, BELOW STATION 101+25.

Number of block.	Date when laid.	Location.	Elevation in feet.					Total subsidence.	
			1881.			1882.			
			June 15.	August 20.	December 24.	April 11.	June 15.	Since June, 1881.	Since blocks were laid.
	1879.								
1	Jan. 31	Station 101+25	1.99	1.95	1.80	1.82	1.78	0.21	0.65
2	Jan. 30		1.91	1.87	1.76	1.74	1.70	0.21	0.69
3	Jan. 30		1.87	1.83	1.73	1.70	1.67	0.20	0.79
4	Jan. 29		2.04	2.03	1.95	1.92	1.90	0.14	0.70
5	Jan. 29	Station 102	2.26	2.24	2.04	2.01	1.98	0.28	0.88
6	Jan. 28		......	......	......	......	......	(*)	(*)
7	Jan. 21		1.41	1.42	1.32	1.36	1.33	0.08	0.86
8	Jan. 22		1.28	1.29	1.20	1.21	1.21	0.07	0.85
9	Jan. 23		1.22	1.21	1.12	1.12	1.12	0.10	0.89
10	Jan. 23		1.22	1.15	0.99	1.00	1.00	0.22	1.05
11	Jan. 24		1.01	0.99	0.86	0.86	0.86	0.15	1.32
12	Jan. 25	Station 103	1.16	1.15	1.05	1.04	1.04	0.12	1.33
13	Jan. 27		1.85	1.85	1.53	1.53	1.53	0.32	1.11
14	Jan. 27		1.88	1.87	1.74	1.73	1.73	0.15	0.95
15	Jan. 31		2.07	2.07	1.97	1.97	1.98	0.09	0.87
16	Feb. 1		1.74	1.73	1.59	1.56	1.59	0.15	1.06
17	Mar. 21		2.22	2.19	2.04	2.02	2.03	0.19	0.82
18	Mar. 21		2.37	2.36	2.25	2.24	2.24	0.13	0.60
19	Mar. 21	Station 104	2.31	2.29	2.21	2.20	2.20	0.11	0.67
20	Mar. 21		2.28	2.26	2.18	2.17	2.17	0.11	0.72
21	Mar. 21		2.33	2.33	2.24	2.24	2.24	0.09	0.78
22	Mar. 24		2.25	2.25	2.16	2.15	2.16	0.09	0.70
23	Mar. 24		2.14	2.16	2.05	2.04	2.04	0.10	0.76
24	Mar. 24	Station 105	2.08	2.07	1.96	1.96	1.96	0.12	0.83
25	Mar. 24		2.02	2.02	1.90	1.91	1.91	0.11	0.86
26	Mar. 24		1.89	1.90	1.79	1.79	1.79	0.10	0.86
27	Mar. 25		1.96	1.96	1.84	1.85	1.85	0.11	0.84
28	Mar. 25		2.09	2.09	1.98	1.98	1.98	0.11	0.83
29	Mar. 25		2.21	2.21	2.10	2.10	2.09	0.12	0.84
30	Mar. 25		2.32	2.33	2.22	2.21	2.21	0.11	0.76
31	Mar. 26	Station 106	2.38	2.38	2.25	2.26	2.26	0.12	0.86
32	Mar. 26		2.34	2.34	2.21	2.19	2.19	0.15	0.93
33	Mar. 26		2.32	2.31	2.19	2.18	2.18	0.14	0.96
34	Mar. 26		2.43	2.43	2.32	2.31	2.31	0.12	0.93
35	Mar. 26		2.42	2.41	2.29	2.28	2.28	0.14	0.94
36	Mar. 27		2.36	2.35	2.22	2.21	2.21	0.15	1.02
37	Mar. 27	Station 107	2.49	2.48	2.37	2.34	2.34	0.15	0.97
38	Mar. 27		2.48	2.46	2.35	2.35	2.34	0.14	0.96
39	Mar. 27		2.49	2.48	2.37	2.35	2.35	0.14	0.86
40	Mar. 27		2.37	2.36	2.26	2.23	2.23	0.14	0.88
41	Mar. 28		2.30	2.29	2.19	2.14	2.17	0.13	0.87
42	Mar. 28		2.13	2.11	1.98	1.94	1.94	0.19	1.13
43	Mar. 28	Station 108	2.13	2.11	1.99	1.95	1.95	0.18	1.17
44	Mar. 29		2.27	2.24	2.13	2.11	2.10	0.17	1.08
45	Mar. 29		2.15	2.13	2.00	1.98	1.98	0.17	1.25
46	Mar. 29		1.95	1.94	1.80	1.76	1.76	0.19	1.50
47	Mar. 29		1.76	1.75	1.63	1.59	1.58	0.18	1.63
48	Mar. 31		1.95	1.92	1.79	1.77	1.77	0.17	1.46
49	Mar. 31	Station 109	1.58	1.57	1.40	1.37	1.38	0.20	1.93
50	Mar. 31		1.61	1.61	1.48	1.42	1.44	0.17	1.66
51	Mar. 31		2.04	2.03	1.84	1.77	1.80	0.24	1.40
52	Mar. 31		2.09	2.08	1.90	1.82	1.84	0.25	1.41
53	Apr. 1		2.34	2.33	2.19	2.15	2.16	0.18	1.21
54	Apr. 1		2.26	2.24	2.05	2.01	2.02	0.24	1.30
55	Apr. 1		2.10	2.08	1.90	1.85	1.86	0.24	1.40
56	Apr. 1	Station 110	1.91	1.88	1.68	1.61	1.64	0.27	1.51
57	Apr. 2		2.03	1.99	1.79	1.73	1.75	0.28	1.50
58	Apr. 2		2.01	1.96	1.78	1.73	1.75	0.26	1.48

[*] Weight of concrete mixer partially rests upon this block and therefore its subsidence is not considered.

Tables giving elevation of concrete blocks, at various dates—Continued.

Number of block.	Date when laid.	Location.	Elevation in feet.					Total subsidence.	
			1881.			1882.			
			June 15.	August 20.	December 24.	April 11.	June 15.	Since June, 1881.	Since blocks were laid.
	1879.								
59	Apr. 2		1.98	1.95	1.77	1.72	1.75	0.23	1.44
60	Apr. 2		1.91	1.89	1.72	1.67	1.69	0.22	1.36
61	Apr. 8		1.99	1.97	1.82	1.78	1.75	0.24	1.37
62	Apr. 3	Station 111	2.14	2.13	1.96	1.94	1.93	0.21	1.28
63	Apr. 3		2.24	2.22	2.08	2.04	2.05	0.19	1.28
64	Apr. 5		2.39	2.36	2.28	2.20	2.20	0.19	1.29
65	Apr. 5	Station 112	2.49	2.47	2.33	2.30	2.30	0.19	1.18
66	Apr. 7		2.67	2.64	2.53	2.48	2.45	0.22	1.16
67	Apr. 8		2.51	2.51	2.30	2.27	2.26	0.25	1.18
68	Apr. 8		2.14	2.12	1.94	1.90	1.89	0.25	1.58
69	Apr. 8		2.36	2.33	2.12	2.06	2.06	0.30	1.45
70	Apr. 8		2.39	2.37	2.17	2.08	2.08	0.31	1.34
71	Apr. 8		2.23	1.70	1.43	1.35	1.35	0.88	2.07
72	Apr. 8		1.87	1.84	1.67	1.61	1.59	0.28	1.70
73	Apr. 10		1.14	1.13	0.86	0.62	0.60	0.54	2.67
74	Apr. 11	Station 113	2.12	2.11	1.94	1.88	1.88	0.24	1.40
75	Apr. 11		2.43	2.43	2.23	2.14	2.15	0.28	1.29
76	Apr. 11		2.60	2.58	2.46	2.39	2.40	0.20	1.06
77	Apr. 17		2.66	2.66	2.52	2.45	2.45	0.21	1.09
78	Apr. 18		2.70	2.67	2.52	2.44	2.43	0.27	1.18
78½	June 30		2.11	2.09	1.93	1.82	1.84	0.27	1.66
79	June 14		1.72	1.67	1.41	1.31	1.30	0.42	1.66
80	June 14		1.73	1.68	1.42	1.32	1.31	0.42	1.55
81	June 16	Station 114	1.81	1.77	1.50	1.39	1.39	0.42	1.58
82	June 16		1.81	1.77	1.49	1.38	1.38	0.43	1.67
83	June 16		1.72	1.66	1.38	1.28	1.27	0.45	1.78
84	June 17		1.83	1.77	1.54	1.45	1.44	0.39	1.41
85	June 17		1.74	1.68	1.39	1.36	1.36	0.38	1.56
86	June 17		1.68	1.62	1.32	1.29	1.28	0.40	1.59
87	June 18	Station 115	1.67	1.60	1.31	1.28	1.27	0.40	1.57
88	June 18		1.73	1.68	1.41	1.38	1.36	0.37	1.62
89	June 18		1.75	1.68	1.42	1.38	1.37	0.38	1.62
90	June 19		1.66	1.61	1.32	1.28	1.27	0.39	1.65
91	June 19		1.66	1.61	1.30	1.25	1.24	0.42	1.71
92	June 19		1.55	1.53	1.13	1.08	1.04	0.51	1.89
93	June 30	Station 116	1.89	1.82	1.07	1.03	1.03	0.86	2.59
94	June 30		2.09	2.04	1.49	1.42	1.39	0.70	2.11
95	July 1		1.24	1.11	0.51	0.35	0.12	1.12	3.35

WEST JETTY, ABOVE STATION 101+25.

Number of block.	Date when laid.	Location.	Elevation in feet.					Total subsidence.	
			1881.		1882.				
			June 15.	August 20.	December 24.	April 11.	June 15.	Since June, 1881.	Since blocks were laid.
	1879.								
1	May 7	Station 101	2.22	2.17	2.06	2.04	2.00	0.22	0.68
2	May 8		2.37	2.27	2.21	2.19	2.14	0.23	0.65
3	May 8		2.31	2.27	2.15	2.14	2.09	0.24	0.70
4	May 8		2.48	2.45	2.33	2.31	2.25	0.23	0.74
5	May 9		2.37	2.35	2.27	2.26	2.23	0.14	0.98
6	May 9		2.23	2.19	2.09	2.07	2.07	0.16	0.61
7	May 9		1.87	1.81	1.72	1.69	1.65	0.22	0.69
8	May 10	Station 100	1.78	1.72	1.63	1.61	1.56	0.22	0.60
9	May 10		1.85	1.82	1.73	1.72	1.67	0.18	0.73
10	May 12		1.93	1.89	1.79	1.78	1.73	0.20	0.60
11	May 12		1.91	1.87	1.76	1.75	1.68	0.23	0.74
12	May 12		1.94	1.89	1.77	1.77	1.71	0.23	0.71
13	May 12		1.92	1.88	1.75	1.75	1.70	0.22	0.71
14	May 13	Station 99	1.81	1.75	1.60	1.60	1.54	0.27	0.81
15	May 13		1.76	1.70	1.57	1.56	1.51	0.25	0.78
16	May 13		1.78	1.72	1.58	1.56	1.52	0.26	0.82
17	May 13		1.90	1.84	1.71	1.68	1.65	0.25	0.79
18	May 13		1.62	1.57	1.42	1.39	1.36	0.26	0.83
19	May 13		1.73	1.66	1.54	1.51	1.49	0.24	0.78
20	May 14	Station 98	1.60	1.57	1.42	1.40	1.37	0.23	0.77
21	May 14		1.38	1.33	1.22	1.20	1.16	0.22	0.70
22	May 14		1.22	1.19	1.12	1.09	1.06	0.16	0.68
23	May 14		1.26	1.23	1.16	1.15	1.12	0.14	0.64
24	May 14		1.38	1.34	1.28	1.26	1.24	0.14	0.52
25	May 14		1.39	1.35	1.29	1.27	1.26	0.13	0.54
26	May 14	Station 97	1.18	1.14	1.09	1.04	1.05	0.13	0.60
27	May 14		1.14	1.11	1.05	1.03	1.02	0.12	0.65
28	May 15		1.17	1.13	1.08	1.05	1.04	0.13	0.69
29	May 15		1.13	1.10	1.03	1.01	1.00	0.13	0.69
30	May 15	Station 96	1.41	1.36	1.30	1.26	1.26	0.15	0.68
31	May 15		1.45	1.40	1.33	1.29	1.27	0.18	0.71
32	May 15		1.52	1.47	1.38	1.35	1.31	0.21	0.72
33	May 15		1.56	1.51	1.43	1.39	1.36	0.20	0.71
34	May 16	Station 95	1.48	1.43	1.33	1.30	1.27	0.21	0.74
35	May 16		1.55	1.51	1.40	1.38	1.34	0.21	0.72
36	May 16		1.56	1.52	1.44	1.43	1.40	0.16	0.64
37	May 16		1.47	1.43	1.36	1.34	1.32	0.15	0.55
38	May 17	Station 94	1.63	1.65	1.57	1.56	1.53	0.10	0.52
39	May 17		1.89	1.88	1.83	1.81	1.78	0.11	0.48
40	May 17		2.12	2.11	2.05	2.02	2.00	0.12	0.45
41	May 17		2.17	2.16	2.09	2.07	2.04	0.13	0.49
42	May 19	Station 93	2.19	2.17	2.11	2.10	2.07	0.12	0.45
43	May 19		2.20	2.19	2.14	2.13	2.11	0.09	0.43
44	May 19		2.34	2.32	2.27	2.26	2.24	0.10	0.37
45	May 20		2.33	2.32	2.26	2.25	2.24	0.09	0.36
46	May 20		2.45	2.43	2.37	2.37	2.34	0.11	0.40
47	May 20	Station 92	2.33	2.31	2.25	2.23	2.21	0.12	0.47
48	May 20		2.24	2.23	2.18	2.15	2.15	0.09	0.37
49	May 20		2.04	2.01	1.97	1.95	1.94	0.10	0.42
50	May 20		1.94	1.92	1.86	1.86	1.84	0.10	0.49
51	May 21	Station 91	2.04	2.02	1.97	1.95	1.95	0.09	0.47
52	May 21		2.23	2.21	2.16	2.16	2.14	0.09	0.44
53	May 21		2.29	2.27	2.23	2.21	2.19	0.10	0.50
54	May 21		2.32	2.30	2.24	2.24	2.22	0.10	0.44
55	May 21	Station 90	2.01	2.00	1.95	1.94	1.92	0.09	0.46
56	May 21		1.55	1.51	1.46	1.46	1.43	0.12	0.49
57	May 22		1.48	1.46	1.41	1.40	1.38	0.10	0.47
58	May 22		1.64	1.62	1.54	1.55	1.54	0.10	0.50
59	May 22	Station 88 + 97	1.84	1.81	1.75	1.76	1.74	0.10	0.49
Average subsidence of 154 blocks								0.22	1.01
Greatest subsidence, block 95, extreme outer end of jetty								1.12	3.35

KIPP DAM.

During the month of July, 1881, eighty-three cords of willows were placed upon this structure, which joins the upper end of the west jetty with the west shore. They were placed throughout its length of 600 feet, making its upper surface 1.5 feet above average flood-tide, and checking the flow of water over it, which, in consequence of its deterioration, was considerable during high river.

WING-DAMS.

With the exception of three wing-dams, previously mentioned, which are built of crib-work, all others placed during the year were constructed of piles and lattice-work, in precisely the same manner as those described in a previous report as having been placed in the pass above Goat Island (see page 1247, Appendix L, of the Annual Report of the Chief of Engineers for 1881), except that the lattice-work is confined between two rows of piles, which are bound together by chain and swivels. Each dam is firmly braced by piles driven at an inclination of 60° with a horizontal, by a driver built for that purpose. Fifteen of these dams have been built, and two of the old mattress dams (Nos. 18 and 19) lengthened by the addition of sections of lattice-work. They are built on or near the sites of mattress dams which were previously used, but which had so much deteriorated as to be of no further value. The locations of these dams are shown on Chart No. 1; they are numbered in the order in which they were built, and corresponding numbers are given in the following table, which gives information regarding the location of and material used in building them.

Table giving information concerning the location of and material used in the construction of lattice wing-dams.

Number of dam.	Location.	Length of dam.	Material used.					
			Number of piles.	Number of feet B. M. 2″ + 6″ scantling.	Number linear feet 6″ + 12″ waling pieces.	Number of carriage bolts.	Number of feet ½-inch chain.	Number of swivels.
		Feet.						
3	Station 11 + 25, east jetty	228	28	4,490	190	526	......	......
4	Station 17 + 70, east jetty	225	26	5,9 4	222	718	......	......
5	Station 22 + 30, east jetty	192	30	5,110	240	700	......	......
6	Station 110, east jetty	160	31	4,800	162	700	......	......
7	Station 110, west jetty	160	45	5,890	150	883	......	......
8	Station 106, east jetty	190	44	3,599	190	714	96	12
9	Station 105, west jetty	198	68	4,256	232	836	195	24
10	Station 89 + 20, west jetty	185	29	4,638	225	674	87	17
11	Station 76, west jetty	200	35	3,584	240	756	54	7
12	Station 89 + 20, east station	210	23	1,805	....	453	......	......
13	Station 76 + 40, east jetty	157	26	2,664	150	489	......	......
14	Station 94, west jetty	207	41	3,805	240	760	55	6
15	Station 100, west jetty	200	44	3,937	232	806	90	10
16	Station 94, east jetty	219	29	3,018	267	574	54	7
17	Station 100, east jetty	212	37	2,702	212	509	69	8
18	Station 71 + 30, east jetty	81	7	2,473	100	316	......	......
19	Station 71 + 30, west jetty	83	8	1,530	73	319	......	......
	Totals	3,107	551	64,225	3,125	10,733	700	84

Another structure which answers the same purpose as these dams, that is, to contract the water-way and thereby increase the channel depth, was built on the west side of the channel, connecting the outer ends of dams Nos. 1 and 2 opposite East Point, and extending 100 feet below the latter. This longitudinal dam or T-head is also built of piles and lattice-work and is located in an average depth of 22 feet of water. Its total length is 1,045 feet, and in its construction 111 piles, 30,763 feet B. M. scantling, and 3,330 carriage bolts were used.

DREDGING.

The dredging done at different localities during the year has amounted in time to eighty-seven days of ten hours each, as follows:

Two days in the pass itself, near Bayou Grande.

Thirty-four days in the "channel through the jetties."

Fifty-one days on lumps beyond the ends of the jetties.

During the months of January and February no dredging was done in the jetty channel, nor was it required, since the effect of the high and rising stage of the river upon the channel was sufficient to maintain it.

This is the longest interval of time since July, 1879, during which no dredging had been done.

ADDITIONAL PLANT.

During the year one pile-driver was built and another rebuilt, the former for driving inclined piles for braces; one flat-boat and one calking flat built and two flat-boats and one barge thoroughly repaired. The wood-work of the dredge "Bayley," consisting principally of her guards, was renewed, as was also a section of her suction pipe, and she is now undergoing thorough repairs to her hull and machinery. One tug-boat and one small launch repaired; two dwellings thoroughly repaired, and a kitchen built to the hotel.

At times, when other work was not required, the force was employed in discharging ballast from vessels and distributing such of the same as was not used for other purposes, to build up a surface above tide-water.

FORCE EMPLOYED.

The average force employed during the year, including officers, mechanics, foremen, laborers, &c., has been sixty in number.

EXAMINATIONS AND SURVEYS.

The examinations and surveys made during the year have been reported to you monthly, and the results of more extended surveys made during the month of June are given herein, and comparisons made with earlier results. The results and comparisons are given in tabular form, or represented graphically on charts and general statements; to aid in a clear understanding of them seems all that is necessary, since in previous reports the methods of presenting them are described in detail, and when once understood, all that is really necessary is to add to the tables or diagrams each new set of results.

At the Head of Passes.—The survey at this point extends over the same area as for two previous years, and is shown on Chart No. 6.

As compared with last year's survey, Northeast Pass has deepened about 2 feet, mostly over the area included between the eastern 30-foot contour and the east shore. The western 30-foot contour has moved to the eastward, and both have assumed a more regular form, conforming in direction more to that of the shore of the pass. As compared with 1875, this pass shows a deepening varying from 1 to 9 feet, being a quite uniform increase of 6 feet, and the greatest increase being below the mattress sill. (See sections E F, G H, and I J, Chart No. 7.)

By reference to Chart No. 6 and sections G H and I J, Chart No. 7, it will be seen that the shoaler area above Upper Dam, which, in a great measure, forms a dividing ridge between the waters of Northeast Pass and the other passes, has increased in area during the year, and now extends farther above the dam than ever before; the 26-foot curve defining it has moved up stream 250 feet during the year, and while the western curve has changed but little, the eastern one has moved to the eastward about 250 feet. From 1880 to 1881 this area deepened, in consequence of the breaks in upper dam, but during the past year it has shoaled an amount in excess of the deepening of the previous year, which shows that this dam is effectual so long as its foundation mattresses are in place.

From section A B, it will be seen that a deepening of about 2 feet has taken place during the year from the main river into South Pass, extending down to opposite upper dam, but below this point the general result is a shoaling varying from 2 to 5 feet. Thirty feet depth in the main river and the same depth in the pass is now divided by a distance of 330 feet, and over the dividing area the depth is so small—a fractional part of a foot less than 30 feet—that we may now consider that a depth of 30 feet may be carried from the main river into South Pass.

Section C D indicates a shoaling of Southwest Pass, though there is a large area in this pass which has deepened about 2 feet during the year. Last year there was but a small area above the mattress sill which had a depth of 30 feet; this area was separated from deeper water in South Pass by an intervening area containing a less depth than 30 feet, which during the year has scoured out, thus making a wide channel of 30 feet depth from South Pass into Southwest Pass.

While the results of last year seemed to indicate that Northeast Pass would eventually increase its flow at the expense of the other passes, it now seems possible that the contrary may follow, for it seems probable, from an inspection of Chart No. 6 and from a knowledge of the recent changes, that the shoaler area now intervening between 30 feet depth in the main river and the same depth in South and Southwest passes will scour out, so that the 30-foot curve on the west side of Southwest Pass Channel will assume a direction the same as that designating 26 feet depth, while the eastern 30-foot curve will be traced from South Pass and inclosing a shoaler area above upper dam, thus making a channel of 30 feet depth into all the passes.

The topographical features represented on Chart No. 6 scarcely need explanation; the representations are mostly of new formations, since the works of improvement were built, and will be readily understood.

Survey of South Pass from its head to South Pass light-house.—During the month of September a survey of South Pass was made, the charts of which are Nos. 4 and 5.

By comparison with the survey made a year previous, the general result indicates but little change throughout the pass during the year. A feature of improvement is noted from the fact that the 30-foot curve above Goat Island has moved down 480 feet, and that above Bayou Grande 600 feet; thus increasing the depth of water to 30 feet, over an area 1,080 feet in length, which had a less depth the year previous. The total length of pass having a less depth than 30 feet is at present 1.2 miles, the shoalest sections being near Picayune and Grande Bayous and above Goat Island.

Commencing at a point 3,000 feet below Head of Passes light-house the west shore of the pass has been built out 50 to 80 feet for a distance of 1,200 feet since 1875, by deposits accumulating in that locality. Below this point, and for a distance of 2,000 feet below the foot of Goat Island, the western bank of the pass has cut away in places; the change, however, is slight, and this section is the only one along which the banks have been affected.

During the year the channel near Bayou Grande, and above Goat Island, has undergone slight fluctuations, and for a few days during the month of February there was but 25 feet depth over a small area above Goat Island. (See Appendix A, certificate dated February 13.) This shoaling resulted from a scouring which was going on at the head of the pass, and as soon as the latter ceased the depth at this locality began to increase. According to my survey of June 20, the least channel dimensions at this point are 26 feet depth by 140 feet width. On the same day the channel near Bayou Grande had a least depth of 26.6 feet, and the least width of the 26-foot channel was 250 feet.

THE CHANNEL THROUGH THE JETTIES.

The channel through the jetties is shown on Chart No. 1. In Appendix A I have given copies of the certificates which you have issued during the year, as they give information regarding the maintenance of channel, not only "through the jetties," but throughout the pass.

This channel has varied its dimensions slightly, from time to time, during the year, as will be seen from the following table, and with but little dredging the required dimensions have been maintained, except for a few days:

Tabulated statements regarding the minimum depths and widths of channel through the jetties, in separate reaches of 2,000 feet each, according to surveys made monthly during the fiscal year ending June 30, 1882.

[Distances from East Point, in feet.]

Date on which soundings were made.	0-2,000.			2,000-4,000.			4,000-6,000.			6,000-8,000.			8,000-10,000.			10,000-12,000.		
	Least depth.	Least width for—		Least depth.	Least width for—		Least depth.	Least width for—		Least depth.	Least width for—		Least depth.	Least width for—		Least depth.	Least width for—	
		26-foot depth.	30-foot depth.		26-foot depth.	30-foot depth.		26-foot depth.	30-foot depth.		26-foot depth.	30-foot depth.		26-foot depth.	30-foot depth.		26-foot depth.	30-foot depth.
1881.																		
June	30	250	20	30.5	280	40	43.8	340	290	32	230	100	31.7	240	120	31.7	230	60
July	31	260	60	32	300	60	42.5	340	300	33.5	280	140	33	260	110	32	220	70
August	30.1	250	40	32	270	60	37.6	330	270	32	240	120	31	210	80	30.2	200	40
October	30.2	250	30	30.3	280	40	38.3	340	270	31.4	220	80	31.2	210	50	30.3	220	30
November	30.8	240	60	31.8	290	50	39.2	310	250	30.4	200	40	30	200	30	30.1	210	30
December	30.2	230	50	31.8	270	60	39.4	280	240	30.8	240	60	30.2	205	40	30	230	20
1882.																		
January	30.5	240	70	30.4	280	60	41.3	330	280	31.1	210	60	30.2	210	50	30.2	230	50
February	31.8	259	100	33	300	80	39.7	320	240	30.5	220	60	30.8	260	70	30.7	240	70
March	31.2	210	120	30.6	250	90	39.2	330	300	30.8	260	40	31.6	250	90	32.5	260	130
April	31.7	210	100	32.6	300	140	39.6	340	290	30.5	280	20	30.3	270	20	33.0	220	90
May	30.5	230	80	33.5	310	120	39.4	390	340	31.0	250	170	31.3	290	70	31.0	230	50
June	30.8	250	60	35.5	320	120	39	370	300	31.2	300	180	31.3	290	90	31.0	185*	80

* This width obtained but for 5 days and was increased to 210 feet.

The least depth "through the jetties" June 30, 1882, was 30.8 feet, the least width of the 30-foot channel was 60 feet, and the least width of the 26-foot channel was 210 feet.

On May 23 the 26-foot channel beyond the ends of the jetties was found to be but 70 feet wide, the obstruction being caused by a narrow spit which had formed between the center lump and one nearest the end of the east jetty. This spit terminated with a small mud lump almost directly in advance of the end of the east jetty, and 600 feet from it, on which a depth of 24 feet was found. It was very small in area, probably not more than 10 or 15 feet square, for with the launch moving as slowly as possible but one sounding could be made upon it each time passing over it.

Dredging was continued at this point until June 5, when stormy weather prevented further work. On June 10, and before any further dredging was done, I made soundings and found that this lump had been removed, and there is now a depth of 29.8 feet at the locality where it existed.

On June 21 my survey showed that the 26-foot channel directly between the ends of the jetties was but 185 feet wide, and was less than 200 feet in width throughout a section 200 feet in length. This width was increased by dredging, and found to be 210 feet on the 26th, following.

The following table gives the minimum depths of "channel through the jetties" at various dates since the commencement of the works of improvement, and serves to show the progressive channel improvement from that time to the present.

Table giving the depths of water through the jetties, at various dates.

Date.	Distances from East Point, in feet.					
	0 to 2,000.	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1875.						
June	22.5	18.7	16.7	10.2	9.7	9.8
1876.						
May	23.3	20.3	22.0	21.0	17.1	15.0
August	23.5	19.6	21.0	23.5	23.0	19.8
November	22.0	20.3	21.1	21.2	21.1	20.8
1877.						
March	24.1	21.1	23.2	22.0	21.2	20.5
July	24.9	24.0	26.0	23.8	23.5	20.8
October 25 to December 14	26.3	24.4	28.5	24.2	23.0	23.7
1878.						
March	26 0	25.9	35.5	25.4	24.3	23.0
December	28.4	26.4	35.7	27.1	25.3	23.0
1879.						
March	28.6	27.5	43.4	27.0	27.0	27.0
June	27.5	28.4	47.7	29.2	29 2	28.0
July 8	30.5	30.7	....	31.0	30.7	30.5
December	31.0	31.0	48.8	31.7	31.8	30.8
1880.						
June	31.0	32.5	47.8	31.4	35.1	32.0
July	30.5	31.0	44.0	30.8	31.5	30.5
August	30.5	30.4	46.0	32.0	32.0	30.5
September	30.7	31.0	44.4	30.6	32.0	31.0
October	31.0	31.5	41.0	30.3	31.0	30.5
November	30.6	31.0	40.3	30.8	30.9	30.5
December	30.9	30.6	43.0	30.8	31.0	30.8
1881.						
January	30.5	30.4	41.9	33.8	30.7	30.8
February	30.4	30.2	41.6	32.0	31.0	30.0
March	31.5	31.2	41.3	32.0	32.0	30.5
April	30.4	30.0	43.0	33.0	33.0	30.5
May	30.2	30.5	42.7	32.6	30.5	31.2
June	30.0	30.5	43.8	32.0	31.7	31.7
July	31.0	32.0	42.5	33.5	33.0	32.0
August	30.1	32.0	37.6	32.0	31.0	30.2
October	30.2	30.3	38.3	31.4	31.2	30.8
November	30.8	31.8	39 2	30.4	30.0	30.1
December	30.2	31.8	39.4	30.8	30.2	30.0
1882.						
January	30.5	30.4	41.3	31.1	30.2	30.2
February	31.8	33.0	39.7	30.5	30.8	30.7
March	31.2	30.6	39 2	30.8	31.6	32.5
April	31.7	32.6	39.6	30.5	30.3	33.0
May	30.5	33.5	39.4	31.0	31.3	31.0
June	30.8	35.5	39.0	31.2	31.3	31.0

During the month of February a scouring commenced in the channel opposite a int on the east jetty, 3,550 feet below East Point. This deepening has been increasg and extending over a large area from month to month, until now its greatest pth is 93 feet, and the area containing a greater depth than 80 feet, is 900 feet long d 300 feet wide. (See Chart No. 1.) During the most rapid scour in this locality the tflow was narrowly confined by strong eddies on either side. A similar deepening k place four years ago a short distance below this locality, and continued until a pth of 114 feet was attained; after a time it began to shoal gradually, until just preous to this later deepening there was a depth of 40 feet, where now the depth of 98 t exists.

During the months of July, 1880 and 1881, the mud lump which has long existed out 700 feet in advance of the present ends of the jetties has been dredged down to feet depth, but with each returning high-river it begins to come up again, and atins its greatest height, that is, the least depth of water is found upon it, during the ghest stage of the river. The least depth on this lump at present is 12 feet.

In the month of April a small lump was located 800 feet in advance of the west jetty d 50 feet west of a line which is the prolongation of that jetty; when first observed was just above the surface of the water, and on May 20 a depth of 4 feet was found n it, while at present it is about 1 foot above the surface at average flood-tide. In ea it is scarcely large enough for a man to stand upon and is cone shaped. The aterial composing it above the surface of the water is reddish clay of about the constency of soft putty, while below the surface the clay is of a bluish color and such as nerally compose these lumps. This is the first appearance of mud lumps above the rface in this locality since the jetties were commenced. The location of this lump shown on Chart No. 1.

The depth of water over the shoal area east of the east jetty has increased slightly ring the year, while over the area to the westward of the west jetty it has decreased a amount varying from 1 to 3 feet.

SURVEYS BEYOND THE ENDS OF THE JETTIES.

1. *Extending to a depth of* 100 *feet*.—Concerning this area, its subdivisions, the methods of obtaining and comparing the results with previous ones scarcely needs repetition, since it is explained in my previous report. (See Appendix L, page 1263, of Report of the Chief of Engineers for 1881.) The chart of this survey is No. 2. By reference to Plate I it will be seen that all the curves except that designating 40 feet depth have advanced during the year, the 50-foot curve showing the greatest movement, of 148 feet, and the 30-foot curve the least, being 28 feet. From this plate the movement of each particular portion of each curve since 1876 and up to the present time may be studied.

On Plate II are given the results of comparisons between 1876 and 1882, from which it will be seen that with the exception of the central and eastern portions of the 20 and 30 foot curves all have advanced since 1876, and it is interesting to note from No. 2 of this plate the regularity with which the advance increases in amount as the depth increases.

The basis of these comparisons has always been the survey of 1876, but as this survey did not extend as far to the westward as later ones have, much of the western portion of the outer curves had to be omitted in order to compare with 1876, and for this reason it might seem that this comparison would not give a fair result, since an equal portion of each curve on either side of a center line parallel to lines which would be the prolongation of the jetties is not considered; such, however, is not the case.

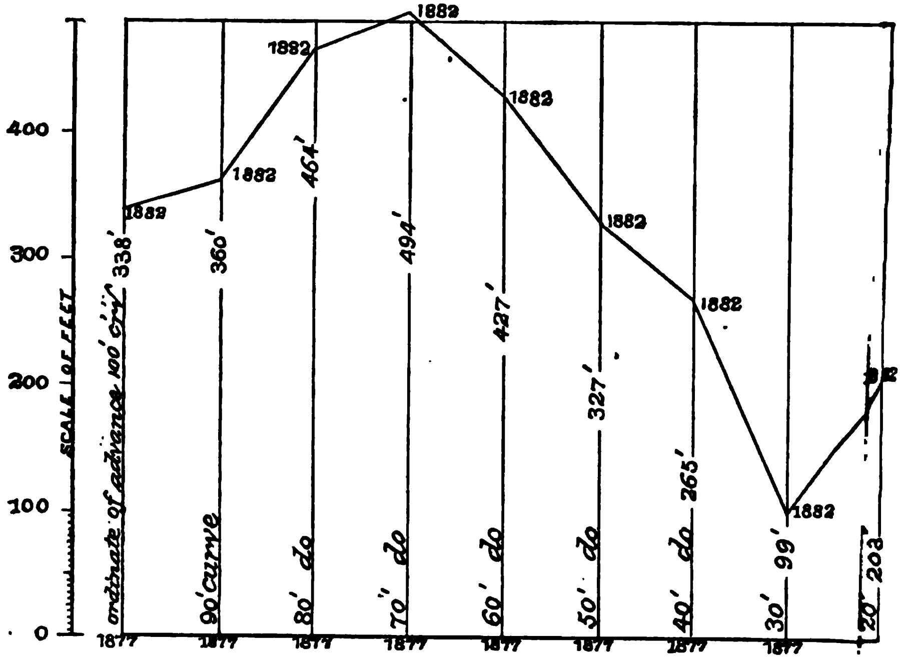
Now if we take the survey of 1877 as a basis, then we may make these comparisons by using the whole of each curve that is given on Chart No. 2. The results will be about the same as by the former comparison out to and including the curve designating 80 feet depth. By reference to part No. 2, Plate II, we see that the 90-foot curve shows the greatest advance, whereas by using the results of 1877 as a basis the 70-foot curve shows the greatest advance.

The accompanying diagram gives the results of comparisons by mean ordinates between 1877 and 1882, and is constructed in the same manner as part No. 2, Plate II; that is, the ordinate of each curve in 1877 being zero, that for 1882 will indicate the amount that each curve has advanced since 1877; for example, we see that from 1877 to 1882 the 30-foot curve advanced 99 feet and the 70-foot curve 494 feet.

From this diagram we see that the advance increases in amount as the depth increases until 70 feet depth is reached, and beyond this it decreases with an increase of the depth, and would seem to indicate that still further out we might find an area which had changed but little, and perhaps deepened, and I think that results hereafter presented as deduced from my survey out to 300 feet depth will show this to be the case.

The fan-shaped area with its 21 subdivisions is shown on Chart No. 2; this area contains 1¼ square miles, its outer limit being little more than a mile beyond the present ends of the jetties.

The following table gives the results of comparisons at different dates, in detail, which have been made to ascertain the amount of deepening or shoaling over this area, and they confirm the results indicated by the diagrams on Plates I and II; in other words, when there is a general advance of the curves we may look for a shoaling over this area, and *vice versa*.



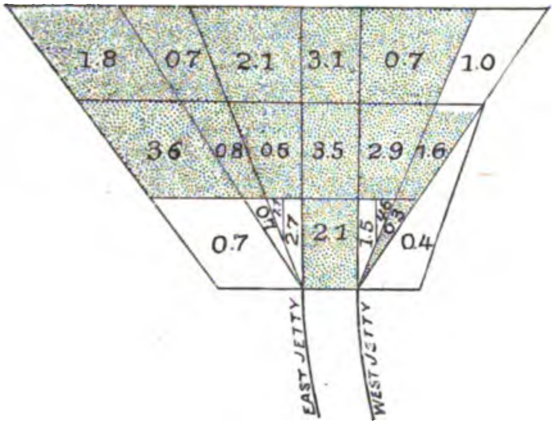
No. of subdivision	Area of subdivision in square feet.	Mean depth of subdivision, in feet.							Quantity of water overlying subdivision, in cubic yards.							Mean depth over whole area.	
		1876.	1877.	1878.	1879.	1880.	1881.	1882.	1876.	1877.	1878.	1879.	1880.	1881.	18 82.	Date.	Mean depth.
1	3, 359, 484	98. 0	86. 3	93. 13	89. 47	93. 87	88. 68	86. 84	12, 193, 080	10, 737, 893	11, 712, 156	11, 133, 335	11, 680, 428	11, 033, 790	10, 805, 592		
2	1, 951, 904	73. 0	76. 43	78. 12	71. 79	70. 05	70. 50	69. 82	5, 277, 360	5, 525, 320	5, 647, 511	5, 190, 423	5, 064, 106	5, 097, 072	5, 047, 191		
3	3, 203, 900	72 524	73. 458	72. 38	69. 32	67. 91	70. 11	68. 02	8, 606, 200	8, 716, 392	8, 588, 820	8, 225, 954	8, 058, 639	8, 319, 105	8, 071, 693	June, 1876	60. 78
4	1, 771, 511	67. 455	67. 877	66. 40	61. 32	61. 92	63. 46	60 37	4, 425, 860	4, 453, 514	4, 356, 630	4, 023, 625	4, 062, 665	4, 163, 967	3, 961, 162		
5	3, 195, 900	75. 342	73. 319	77. 00	74. 26	76. 47	72. 21	71. 52	8, 917, 980	8, 678, 488	9, 185, 253	8, 7 9, 980	9, 051, 617	8, 547, 376	8, 465, 109		
6	1, 951, 904	76. 724	81. 0	75. 34	74. 12	75. 57	71. 81	72. 82	5, 546, 570	5, 855, 700	5, 446, 535	5, 358, 410	5, 463, 379	5, 191, 196	5, 264, 429	June, 1877	60. 38
7	3, 146, 568	63. 63	62. 45	66. 38	62. 60	63. 57	59. 82	56. 25	7, 415, 403	7, 277, 866	7, 735, 899	7, 303, 062	7, 408, 419	6, 971, 623	6, 554, 878		
8	1, 177, 965	58. 40	59. 50	59. 74	58. 30	58. 62	53. 23	52. 41	2, 547, 905	2, 595, 882	2, 606, 356	2, 543, 532	2, 557, 449	2, 322, 466	2, 286, 779		
9	1, 911, 590	53. 7826	53. 892	56. 30	56. 58	52. 63	50. 59	50. 05	3, 807, 800	3, 815, 012	3, 986, 015	4, 005, 839	3, 726, 397	3, 581, 962	3, 543, 659	July, 1878	62. 18
10	1, 804, 280	47. 9336	48. 845	51. 83	47. 70	49. 12	49. 41	45. 96	3, 203, 170	3, 264, 076	3, 463, 548	3, 187, 621	3, 282, 921	3, 302, 099	3, 071, 285		
11	1, 910, 900	52. 4822	54. 075	56. 38	54. 54	54. 80	53. 53	50. 63	3, 714, 389	3, 827, 022	3, 990, 242	3, 860, 303	3, 878, 490	3, 788, 890	3, 583, 220		
12	1, 177, 965	50. 5625	52. 144	49. 97	51. 05	50. 75	48 85	46. 75	2, 205, 950	2, 274, 950	2, 180, 110	2, 227, 401	2, 214, 138	2, 109, 604	2, 039, 755	July, 1879	59. 62
13	2, 664, 385	36. 803	38. 418	39. 57	40. 35	39. 67	36. 34	36. 99	3, 631, 752	3, 793, 006	3, 904, 805	3, 982, 775	3, 914, 672	3, 586, 460	3, 650, 997		
14	354, 931	31. 464	37. 02	35. 00	34. 73	33. 63	32. 76	33. 47	413, 612	486, 650	460, 095	456, 546	442, 086	430, 619	439, 983		
15	196, 900	35. 20	36. 325	40. 01	40. 26	35. 26	33. 11	34. 26	256, 699	261, 803	291, 766	293, 590	257, 159	241, 468	249, 844	June, 1880	59. 74
16	395, 320	33. 377	36. 471	35. 92	39. 01	37. 43	33. 74	36. 47	488, 689	533, 968	525, 922	571, 281	548. 133	494, 018	533, 989		
17	1, 658, 310	29. 2805	33. 256	32. 20	33. 16	32. 64	30. 32	28. 18	1, 798, 376	2, 042, 546	1, 977, 689	2, 0 6, 957	2, 004, 525	1, 862, 282	1, 730, 600		
18	390, 660	31. 444	32. 905	34. 00	35. 92	33. 07	29. 75	31. 22	451, 959	476, 003	491, 942	510, 838	478, 515	430, 449	451, 762	June, 1881	57. 36
19	195, 900	37. 0833	35. 1	39. 43	39. 47	37. 69	37. 17	41. 78	269, 090	254, 585	283, 086	286, 413	273, 469	260, 696	303, 115		
20	354, 931	35. 654	36. 85	37. 20	33. 47	32. 99	29. 62	29. 36	468, 690	484, 415	489, 016	410, 088	433, 686	389, 439	385, 955		
21	1, 942, 785	35. 012	31. 723	36. 50	30. 93	28. 17	22. 55	22. 97	2, 519, 288	2, 282, 681	2, 626, 357	2, 225, 567	2, 027, 518	1, 622, 656	1, 653, 166	June, 1882	56. 06
	*34, 717, 993	1, 095. 1537	1, 107. 378	1, 134. 40	....	....	......	....	78, 163, 422	77, 640, 825	79, 952, 753	76, 662, 548	76, 828, 444	73, 756, 267	72, 094, 163		

*Square miles, 1. 2453.

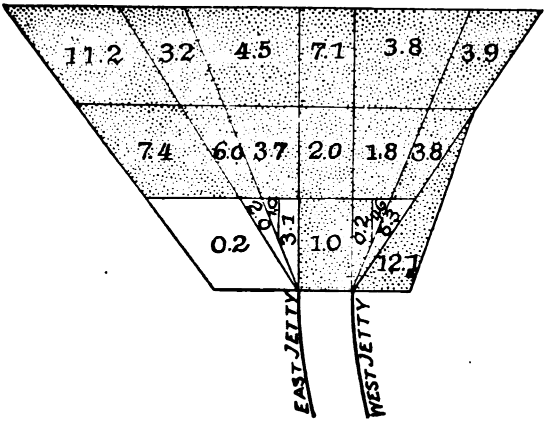
	Feet.
Mean fill over whole area from 1876 to 1877	0. 40
Mean scour over whole area from 1877 to 1878	1. 80
Mean fill over whole area from 1878 to 1879	2. 56
Mean scour over whole area from 1879 to 1880	0. 12
Mean fill over whole area from 1880 to 1881	2. 38
Mean fill over whole area from 1876 to 1881	3. 42
Mean fill over whole area from 1881 to 1882	1 30
Mean fill over whole area from 1876 to 1882	4. 72

I think the changes in this area will be better understood from the following diagra representing it on a small scale. The figures in each subdivision are the differen between the mean depths in these divisions, and therefore express the amount shoaling or deepening in each during the period under consideration; shaded ar denote shoaling, and blank areas deepening. No. 1 gives the results, which are deduc by comparing the depths in 1881 with those in 1882, and No. 2, by comparing the dept in 1876 with those in 1882:

No 1.
1881–1882.



No. 2.
1876–1882.



From No. 2 we see what is clearly indicated by previous diagrams, and that is a general shoaling over this area, the same increasing in amount with the depth of water.

Survey extending out to a depth of 300 *feet of water.*—In compliance with your orders Captain Ellis, Master of steamer Arbutus, reported to me at 5.30 a. m., June 27, for duty in connection with this survey. At 8 a. m. everything was in readiness for the work, which was commenced after a delay of two hours, caused by a rain squall. This survey was completed on the 29th, after twenty seven hours' actual work, having run 10 lines, averaging 7 miles in length from the end of the jetties, and making 626 soundings. The position of the vessel was located every five minutes by angles read from the stations near shore, together with sextant angles on board. As much care was taken in making the soundings, and having calm weather, with other conditions favorable, they are as accurate as could be obtained with lead and line.

The chart of this survey is No. 3, and on the same chart are profiles by which the depths may be compared with those obtained by similar surveys in 1876 and 1879. Only five lines of the survey of 1876 are used in these comparisons, since only this number are in the same localities as the later one.

Some of the soundings taken in 1879, on a line corresponding to No. 4, seem to have been in error, as was indicated in the development of the survey at that time; I mentioned this apparent error at the time, but it was deemed best to present the results obtained.

The soundings this year and in 1876 as taken in this locality would indicate a probable error, at least in 1879, since from our knowledge of the changes in the Gulf bottom it is not probable that a shoaling of 40 or 50 feet in a single locality in three years would be erased during the next succeeding three years.

By using the five lines (1, 3, 4, 7, and 10), which can be compared with others in the same locality in 1876, it will be seen that the general result is a shoaling varying from 5 to 15 feet and extending out to about 200 feet depth of water, and at this locality there seems to be an area which has changed but little, while beyond this depth there is a deepening on lines 3 and 10, a shoaling on 1 and 4, while on 7 there are localities which have deepened while others have shoaled, and still others seem unchanged.

By comparing the depths on the remaining 5 lines (2, 5, 6, 8, and 9) with those of 1876, we find on No. 2 an alternate deepening and shoaling; on No. 5, a decided shoaling out to 140 feet depth, a slight deepening to 220 feet depth, and a general deepening beyond; on No. 6, a deepening out to 130 feet depth, a shoaling out to 200 feet depth, and a general deepening beyond; on No. 8, a shoaling out to 100 feet depth and a general deepening beyond; on No. 9, a general deepening out to 220 feet depth and a decided deepening beyond this locality.

From the evidence furnished by these comparisons a conclusion regarding the changes in the Gulf bottom, seaward from the ends of the jetties, since 1876, may, I think, be arrived at, which is that from the ends of the jetties and for a distance of three miles out there has been a shoaling varying in amount from 5 to 15 feet, and that at a distance of 3 miles out, or in the neighborhood of 220 feet depth of water, there is an area which has changed but little, while beyond this area there has been a deepening varying in amount from 5 to 15 feet.

The existence of this area of least or no change was anticipated in concluding my deductions from the results given on a diagram on page 1348.

VELOCITY OF THE SURFACE CURRENT IN THE JETTY CHANNEL AND GULF OF MEXICO.

In compliance with your request I made determinations regarding these velocities, the results of which are given in detail on Chart No. 7. These observations were made May 15, on which day the Gulf was very calm, wind east to northeast, varying in velocity from 4 to 12 miles per hour, and the tide ebbing at the rate of two-tenths of a foot per hour, falling 1.4 feet in seven hours. These conditions are exceptional, particularly regarding the wind and a calm sea, and while the results are interesting they can scarcely be considered of much value, especially as a basis for theory. The only results which could be of value would be those deduced from a series of observations made during different stages of the river, and including different conditions of the wind, tide, &c., for the effect of wind and tide upon the surface velocity is clearly evident from the results presented on Chart No. 7; but such results cannot be obtained, since a calm sea is absolutely necessary in order that these observations may be made, and as this is exceptional, only obtaining during comparatively few days in a year, the results on such days must necessarily be exceptional to a general result.

The float used in these observations was a cork having a surface 5 inches square, and was 2 inches thick, sufficiently weighted so as to immerse it about one-half its thickness. It was located every minute by angles read from stations to a small flag held directly over it, the staff of which was fastened at right angles to a pole 20 feet long, which was carried in a boat from which it was used. In this way I was able to use so small a float, and thereby avoid the wind effect as much as possible.

It is unnecessary to detail the results of each set of observations, as I think they a clearly shown and will be readily understood from the chart above referred to. A the commencement of the first set of observations the tide was four-tenths of a fo above average flood, and had been ebbing the shortest time, and the wind had attaine about its maximum velocity, while during the last set (No. 5) the wind was but miles per hour, and the tide had fallen 1.2 feet during the six hours previous, and th change in direction of the path of the float may be readily accounted for by the chang in these conditions.

In No. 2 the float was started near the end of the east jetty and out of a direct cu rent, and its path was along the dividing line between muddy and clear water, keeping in the latter, and about 1 foot from the line most of the way out.

As will be seen, the greatest velocity in the jetty channel is through the narrowes section which terminates with a solid dam of crib-work on either side; the diminution of velocity in the next or outer section might be accounted for in disturbance caused while placing cribs for the outer wing-dam at the end of the west jetty, a this work was done during the time I was making these observations, having bee commenced after I had completed one set.

During six months of the year I was assisted by Assistant Engineer Thomas L. Raymond, and throughout the year by Recorder G. W. Lawes, to both of whom I am indebted for valuable assistance.

Very respectfully, your obedient servant,

C. DONOVAN,
Assistant Engineer.

Capt. W. H. HEUER,
Corps of Engineers.

A.

UNITED STATES INSPECTING OFFICER'S CERTIFICATES FOR MAINTENANCE OF CHANNE AT THE MOUTH AND HEAD OF SOUTH PASS OF THE MISSISSIPPI RIVER, AND ALS THROUGH "THE PASS ITSELF," AS DESIGNATED BY ACTS OF CONGRESS APPROVE MARCH 3, 1875, AND MARCH 3, 1879.

UNITED STATES ENGINEER OFFICE,
Port Eads, La., August 13, 1881.

I certify that between the dates of May 10, 1881, and August 9, 1881, both dates inclusive, Mr. James B. Eads maintained "a channel through the jetties" at the mouth of South Pass of the Mississippi River, "26 feet in depth, not less than 200 feet in width at the bottom, and having through it a central depth of 30 feet without regard to width." The width of "200 feet at the bottom" was not preserved, however, until deeper water in the Gulf of Mexico was reached, but was contracted to 110 feet between two lumps which are 700 feet seaward of the end of the east jetty. This deficiency was determined by a survey made June 24, a chart of which accompanies this certificate; another survey, made June 28, shows this width to have been increased to 210 feet by dredging, which had been done in the mean time. There were, therefore, four days (June 24, 25, 26, and 27) during which a channel "26 feet in depth, not less than 200 feet in width at the bottom," did not exist beyond the present ends of the jetties, at the locality above mentioned.

Depths were reduced to the plane of "average flood-tide, which is indicated by a reading of 2.76 feet on United States engineers' gauge at South Pass light-house.

During the above-mentioned period (May 10, 1881, to August 13, 1881) a channel, having "a navigable depth of 26 feet," was maintained through the shoal at the head of South Pass and "through the pass itself."

W. H. HEUER,
Captain of Engineers.

UNITED STATES ENGINEER OFFICE,
Port Eads, La., November 13, 1881.

I certify that between the dates of August 14, 1881, and November 13, 1881, both dates inclusive, Mr. James B. Eads maintained "a channel through the jetties, 'at the mouth of South Pass of the Mississippi River, "26 feet in depth, not less than 200 feet in width at the bottom, and having through it a central depth of 30 feet without regard to width."

Also that during the above-mentioned period (August 14, 1881, to November 13, 1881) a channel having "a navigable depth of 26 feet" was maintained through the shoal at the head of South Pass and "through the pass itself."

Depths were measured at "average flood-tide."

W. H. HEUER,
Captain of Engineers.

UNITED STATES ENGINEER OFFICE,
Port Eads, La., February 13, 1882.

I certify that between the dates of November 14, 1881, and February 13, 1882, both dates inclusive, Mr. James B. Eads maintained "a channel through the jetties" at the mouth of South Pass of the Mississippi River, "26 feet in depth, not less that 200 feet in width at the bottom, and having through it a central depth of 30 feet without regard to width."

Also, that during the above-mentioned period a channel having "a navigable depth of 26 feet" was maintained through the shoal at the head of South Pass. Depths were measured at "average flood-tide."

W. H. HEUER,
Captain of Engineers.

CERTIFICATE REGARDING THE DEPTH OF WATER "THROUGH THE PASS ITSELF."

I certify that between the dates of November 14, 1881, and February 5, 1882, both dates inclusive, a channel having "a navigable depth of 26 feet" was maintained "through the pass itself," but from February 6, 1882, to February 13, 1882, such navigable depth did not exist in the pass at a point 1¼ miles below Head of Passes light-house, when depths are reduced to a plane indicated by a reading of 1.8 feet on a gauge at Head of Passes light-house; but considering the stage of river (high) during this latter period, the actual depth would be 1.7 feet more at high-tide, 1.2 feet more at low-tide, and 1.5 feet more at mean tide, than when reduced to the plane above referred to.

If a plane of reference in conformity with the opinion of the Board of Engineers appointed by Special Orders 229, Headquarters Army, Adjutant General's Office, November 2, 1876, be used, that is, "if the measure of depths be from the level of average high-tides occurring during the stage of the river when the volume is least," then the depth would be 0.6 foot more than if reduced to a plane indicated by a reading of 1.8 feet on gauge.

The following are, therefore, the results according to the above statements, viz:

1. When depths are reduced to a plane indicated by a reading of 1.8 feet on gauge the distance over which "a navigable depth of 26 feet" did not exist (from February 6 to February 13, 1882, inclusive) was 400 feet, and the least depth over this area was 25 feet.

2. If the stage of river at the time the soundings were made be considered, then "a navigable depth of 26 feet" did exist throughout the quarter from November 14, 1881, to February 13, 1882, inclusive, for in this case the plane of the river's surface at low-tide was 1.2 feet above the plane to which the depths were reduced (1.8 feet on gauge).

3. If the depths are reduced to a plane which is the mean of the high waters of the river at this place taken for one or more lunations when the river is at what is known as its low stage, then the least depth would be 25.6 feet, and the distance over which "a navigable depth of 26 feet" did not exist would be 400 feet.

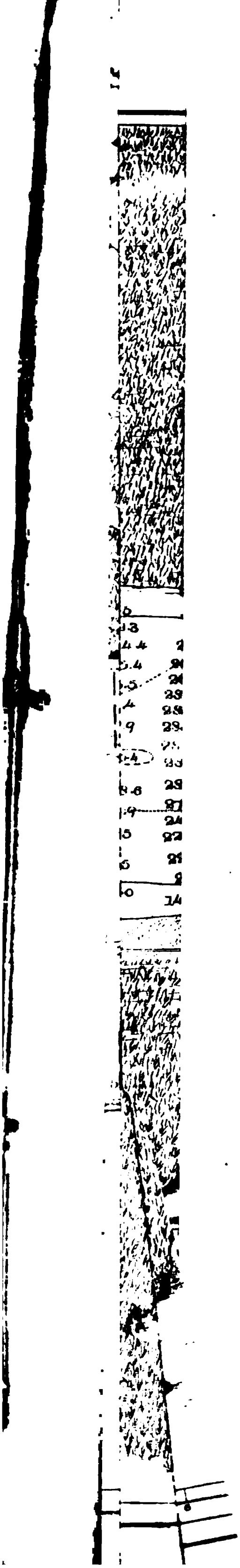
W. H. HEUER,
Captain of Engineers.

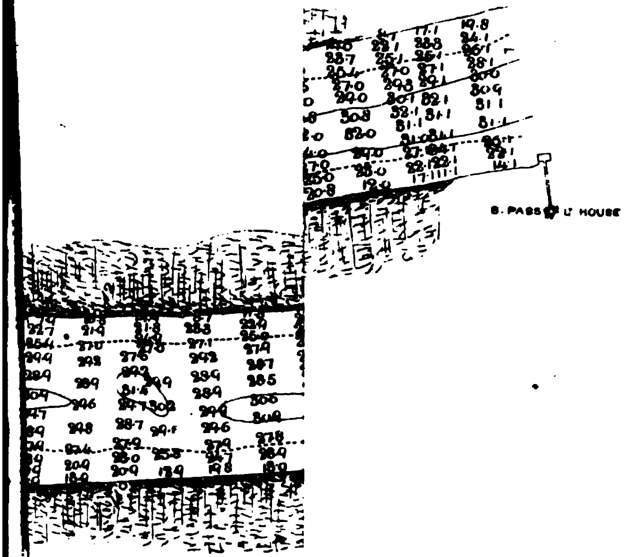
UNITED STATES ENGINEER OFFICE,
Port Eads, La., May 13, 1882.

I certify that between the dates of February 14, 1882, and May 13, 1882, both dates inclusive, Mr. James B. Eads maintained "a channel through the jetties" at the mouth of South Pass of the Mississippi River, "26 feet in depth, not less than 200 feet in width at the bottom, and having through it a central depth of 30 feet, without regard to width."

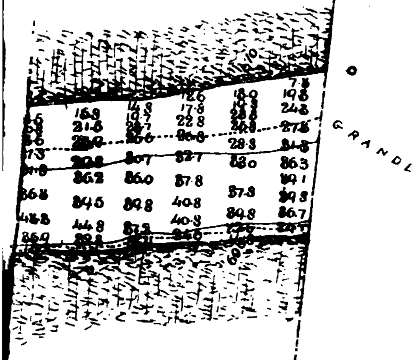
During the above-named period a channel having "a navigable depth of 26 feet" was maintained through the shoal at the head of South Pass and "through the pass itself."

W. H. HEUER,
Captain of Engineers.





New Orleans, La. July 26th, 1882.
Chief of Engineers, U.S.A. with
ending June 30th, 1882.
W. H. Heuer
Captain of Engineers, U.S.A.



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of Engineers U.S.A. with
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W.H. Heuer.
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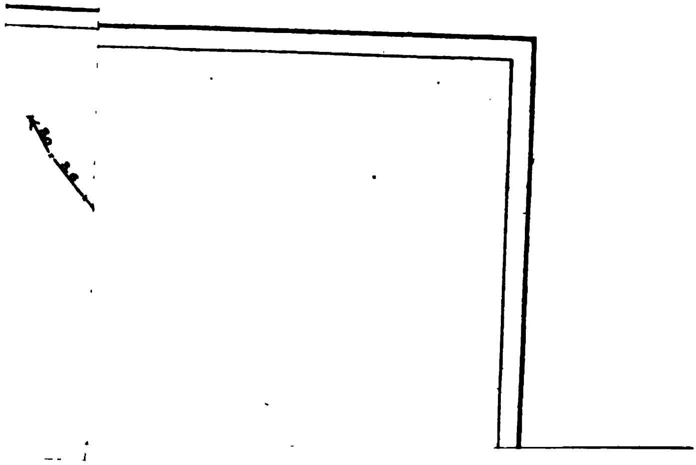

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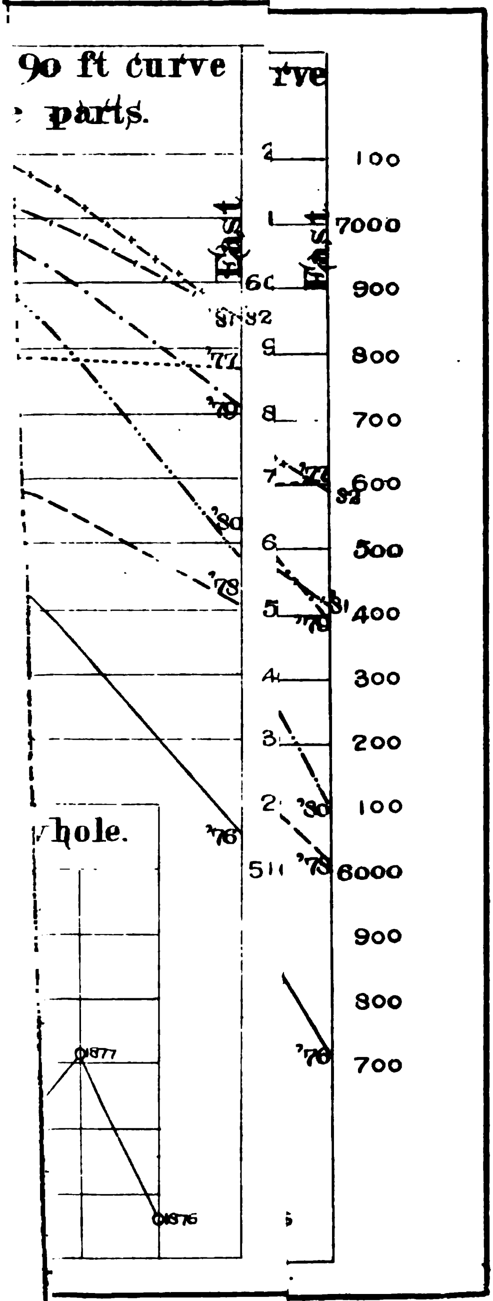
90 ft curve
parts.
rve
East
East
'81 '82
'77
'79
'77
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'78
'81
'79
'80
'78
'76
'76
hole.
1877
1876
2
1
60
9
8
7
6
5
4
3
2
51
100
7000
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600
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200
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APPENDIX M.

MPROVEMENT OF HARBOR OF NEW ORLEANS; OF PEARL RIVER, MISSISSIPPI; OF BAYOUS TECHE AND BLACK, AND OTHER WATER-COURSES IN LOUISIANA; CONNECTION OF BAYOU TECHE WITH GRAND LAKE AT CHARENTON.

REPORT OF MAJOR AMOS STICKNEY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at New Orleans, La.
2. Pearl River from Jackson to Carthage, Miss.
3. Pearl River below Jackson, Miss.
4. Amite River, Louisiana.
5. Vermillion River, Louisiana.
6. Tangipahoa River, Louisiana.
7. Tchefuncte River, Louisiana.
8. Tickfaw River, Louisiana.
9. Bayou Teche, from Saint Martinsville to Port Barre, La.
10. Connection of Bayou Teche with Grand Lake at Charenton, La.
11. Bayou Black, Louisiana.
12. Bayou Courtableau from Port Barre to Atchafalaya, Louisiana.
13. Bayou Terre Bonne, Louisiana.
14. Bayou La Fourche, Louisiana.
15. Calcasieu River from Phillips' Bluff to its mouth.
16. Calcasieu Pass, Louisiana.
17. Pass Marianne, Mississippi Sound.

EXAMINATIONS AND SURVEYS.

18. Breakwater at Lake Pontchartrain.
19. Atchafalaya River, Louisiana.
20. Grand Caillou Bayou.
21. Little Caillou Bayou.
22. Pass Mauchac and Bayou Manchac, Louisiana, from its mouth to the Mississippi River.
23. Bayou Plaquemine, Louisiana.
24. Bayou Fusilier, Louisiana.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., August 24, 1882.

GENERAL: I have the honor to transmit herewith the annual reports of the works of improvement and examinations and surveys in my charge for the fiscal year ending June 30, 1882.

These works, with exception of removal of wreck in Pass Marianne, were in charge of Maj. C. W. Howell, Corps of Engineers, till December 1, 1881, since which time they have been in my charge.

Capt. D. W. Lockwood, Corps of Engineers, has served under the immediate orders of the officer in charge during the year.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers, U. S. A.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

M 1.

IMPROVEMENT OF HARBOR AT NEW ORLEANS, LOUISIANA.

This work originated from a survey made in the winter of 1877 an 1878, under the direction of a Board of Engineers, convened at the re quest of the city authorities of New Orleans to consider plans for th protection of the harbor front of New Orleans from the effects of cavin banks of the Mississippi along that front. (See Report of Chief of E gineers, 1878, Vol. 1, Appendix J 10.)

The United States assumed charge of the work in 1878, and an ap propriation of $50,000 was made for its commencement. Under thi appropriation work was begun and continued by hire of labor and pu chase in open market until the appropriation was exhausted. (See R port of Chief of Engineers for 1879, Appendix K 1, and for 1880, Ap pendix M 1.)

By act of Congress approved March 3, 1879, further appropriatio was made to the amount of $60,000, and under this the work was pu out at contract, John Roy being the contractor. The contract was e tered into December 26, 1879, and annulled February 10, 1881. For a account of the work done under this contract with John Roy, and th causes which led to its annullment, see Report of Chief of Enginee for 1881, Appendix M 1. At the close of the fiscal year, June 30, 1881 the contract had been assumed by two of Roy's sureties, F. A. Beha and W. H. Beanham, the third surety, F. E. Foucher, having failed t signify his intention of taking part, although addressed several time on the subject.

By virtue of a power of attorney executed March 18, 1881, F. A. Behan was authorized to act for and in behalf of W. H. Beanham.

The original contract specified that the work of laying mats shoul commence when the river had reached a 7-foot stage as indicated b the Carrollton gauge. After this stage had been reached but littl progress was made in the work; one mat was placed in position on th river-bed August 24, and another September 7.

Under date of September 13 Mr. Behan was informed that the manner in which the work was being carried on was unsatisfactory, th he was not using due diligence, and directing him to furnish this offic with satisfactory assurances, within five days, of his ability and intention to prosecute the work more rapidly, or the engineer in charge woul consider it his duty to recommend that the contract be totally annulled

To this Mr. Behan replied, under date of September 19, giving a reasons for delay the obstructions in the river, which prevented layin the mats on the bottom; the presence of shipping, which interfered wit his launching barge; and interference of the wharf lessee, who was engaged in constructing wharves in the vicinity of the work. Work wa stopped upon the receipt of the following telegram:

WASHINGTON, D. C., *September* 28, 1881.

Major HOWELL, *Engineers:*

Secretary of War directs that all operations for improving harbor at New Orlean under present plan be at once discontinued.

WRIGHT,
Chief of Engineers.

On the following day a telegram was received stating that the pla under which work had been carried on was abandoned. Since then Mr Behan has put in a claim for damages, amounting in the aggregate t $36,350.39.

This claim, with a history of the case, was forwarded to the Chief of Engineers, under date of January 27, 1882, for the instructions of the department, without taking any other action, for the reason that the case presented some complications, arising from the question of propriety of items of claim and the status of Behan.

According to instructions contained in indorsement from Engineer Department, dated February 2, 1882, returning the papers presented by Behan, and directing that the accounts be thoroughly examined, I referred them to Assistant Engineer Douglas, who had acted as inspector of the work, and who made a careful and critical examination of and report on each item of expenditure claimed by Behan. This report, with all papers relating to the matter, was returned to the Chief of Engineers under date of May 10, 1882, since which time the claim of Behan has been placed before the Court of Claims.

By act of Congress approved June 14, 1880, an appropriation of $75,000 was made for continuance of improvement. The contract under this appropriation was awarded to James E. Slaughter, and articles of agreement were entered into October 16, 1880. (See Report of Chief of Engineers for 1881, Appendix M 1.) This work was located in Carrollton Bend, and was commenced August 12, and continued until September 29, when it was stopped by the telegram from the Chief of Engineers already given.

Twenty-seven cane mats, 200 by 84 feet, were laid, covering about 2,268 feet along the river bank. When work was stopped the contractor put in a claim for $23,390.26 for value of plant, material, &c., on hand at the time. This claim was referred by my predecessor to the Chief of Engineers, who referred it to Capt. D. W. Lockwood, Corps of Engineers, for report. He recommended that $14,429.98 be allowed. Eventually Mr. Slaughter was paid $16,095.26, the government retaining possession of the material on hand for making mats, and the contractor the plant for launching, &c.

In September, 1881, a Board of Engineer officers was convened to consider the subject of the improvement of the harbor of New Orleans.

ORDER CONVENING BOARD.

[Special Orders, No. 97.]

HEADQUARTERS CORPS OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., September 12, 1881.

[Extract.]

1. By direction of the Secretary of War a Board of Engineer officers, to consist of Maj. C. R. Suter, Maj. W. H. H. Benyaurd, Maj. Amos Stickney, Capt. O. H. Ernst, will assemble at New Orleans on the 20th instant, or as soon thereafter as practicable, to examine the present condition of the work in progress for the protection of the river front of that city, and to report upon the questions connected therewith contained in letter of instructions of this date. * * *

By command of the Acting Chief of Engineers.

GEO. H. ELLIOT,
Major of Engineers.

A resurvey of the bend at Carrollton and the one in the third district was at once commenced, in accordance with the instructions of the Board, and upon its completion the Board reassembled at New Orleans February 17, 1882.

During February, April, May, June, and August soundings were taken on selected lines in the third district, running out from 220 to 250 feet from shore, for the purpose of determining the nature and amount of changes that might be taking place in that locality.

By act of Congress approved March 3, 1881, $75,000 were appropriated for continuation of the work. Under date of September 6, 1881, a project was submitted by my predecessor, Major Howell, for expenditure of this amount in continuing the work then in progress in Carrollton Bend. This project was not approved, and since the time when work was stopped by the Chief of Engineers nothing has been done except making the surveys in the third district already referred to. No new project has been submitted for this work, as from the terms of the river and harbor bill it seemed probable that the work would be placed under the supervision of the Mississippi River Commission.

The work is in the collection district of New Orleans. The nearest light-house is at the mouth of the Mississippi River.

Total amount appropriated	$260,000 00
Total amount expended	114,546 72

Statement showing the number of vessels, steam and sail, entered at and cleared from the port of New Orleans; total value of imports, specie, free and dutiable; total value of exports, domestic, to foreign countries; total value of exports, foreign, to foreign countries; grand total of exports, and amount of revenue collected on imports, for the fiscal year ending June 30, 1882:

		Tonnage.
Number of entrances of steam vessels	495	798,367
Number of entrances of sail vessels	424	221,579
Totals	919	1,019,946
Number of clearances of steam vessels	524	834,308
Number of clearances of sail vessels	445	231,541
Totals	969	1,065,849

Imports:		
Merchandise free		$3,507,720
Merchandise dutiable		8,710,326
		12,218,046
American silver dollars		5,209
Foreign silver dollars		116,996
		122,205
Exports:		
Value of domestic merchandise		70,657,860
Value of foreign commodities:		
Free	$24,956	
Dutiable	338,931	
		363,887
Total		71,021,747
Export silver bullion		1,101
American silver dollars		20,740
		21,841
Revenue collected on imports		3,060,980 62
Total amount appropriated		260,000 00
Total amount expended		114,546 72

Money statement.

July 1, 1881, amount available		$198,475 45
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$50,681 64	
July 1, 1882, outstanding liabilities	2,340 53	
		53,022 17
July 1, 1882, amount available		145,453 28
Amount available for fiscal year ending June 30, 1883, and in addition such amount as may be allotted by the Mississippi River Commission		145,453 28

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 16, 1882.

SIR: In answer to the reference of a resolution of the Senate of January 5, 1882, directing that—

> The Secretary of War transmit to the Senate a copy of any and all papers relating to the repair or improvement of the Mississippi River levee in front of the city of New Orleans—

I have the honor to submit the accompanying copies of papers from the files of this office, marked 1 to 6, inclusive, which will fully explain the origin and progress of the work of bank-protection thus far applied to certain portions of the water-front of New Orleans, and the difficulties attending it.

It will be perceived that in accordance with the recommendation of a Board of Engineer Officers which it was found advisable to convene to consider the question of the propriety of continuing the plan of improvement adopted, and, if necessary, to mature a new plan for the protection of the river-front, all operations then in progress were, with your sanction, suspended on the 28th September last.

The accounts of the contractors whose work was discontinued in consequence of this determination are in course of adjustment, but a final settlement with them has not as yet been made.

The time of resumption of work upon this improvement, and the plan for its prosecution which may be recommended for adoption for the future, will depend in a great measure upon the results of the investigations of the above-mentioned Board of Engineer Officers, who still have the subject under consideration, but whose final report thereon has not as yet been received at this office.

Very respectfully, your obedient servant,

H. G. WRIGHT,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

HON. ROBERT T. LINCOLN,
Secretary of War.

LETTER OF THE CHIEF OF ENGINEERS.

CLINTON, CONN., *September* 10, 1881.

GENERAL: In accordance with previous arrangements, I met the Hon. Secretary of War and the Hon. E. John Ellis, M. C., at Long Branch, yesterday.

From the photographic views of portions of the river-front at New Orleans, it appears that the current has made serious inroads upon the banl since the river commenced falling, and that, unless there be some erro in the statements of Mr. Ellis in regard to the locality, the part of th front upon which the protecting works have been applied by Majo Howell has suffered equally with that upon which no work has bee done—in other words, that the system of protection adopted has prove a failure.

The result of the consideration of the subject was to convene a Boar of Officers of the Corps to meet at New Orleans at as early a day as practicable, to examine into the subject anew with all the light that th past experience of Major Howell may afford. The Board is to consis of Majors Suter, Benyaurd, and Stickney, and Captain Ernst; and yo will please issue the order by direction of the Secretary of War.

As the working season is limited to low river, and is therefore short it is of the first importance that the Board be got together as soon a possible. It may be practicable for all the members to get there by th 20th inst., if they are given telegraphic notice to get ready; but if yo think a later date better, you will so arrange it, of course.

If the work already done has failed in its object, its further prosecution should be stopped as soon as practicable. You will therefore pleas instruct the Board to first consider the question of the propriety o continuing the present plan of improvement, and to report their view thereon at the earliest day practicable. There are two contracts unde way now, I believe, and work under them should cease at once, if the Board reports adverse to the present plan.

The Board should be instructed to afterwards proceed to consider and mature a new plan for the protection of the river-front (harbor of New Orleans) and to report the same without unnecessary delay. It is desirable that the Board invite the views of persons in New Orleans interested in the subject of the protection of the harbor, and especially of the Hon. Mr. Ellis, the Representative from the New Orleans Congressional district.

Of course, any further instructions that may suggest themselves to you should be given.

Very respectfully, your obedient servant,

H. G. WRIGHT,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

General JOHN G. PARKE, U. S. A.,
Acting Chief of Engineers.

LETTER OF PRESIDENT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
BOARD ROOM,
New Orleans, La., September 23, 1881.

GENERAL: The Board of Engineer Officers convened by your Special Order No. 97, to consider and report upon the work of improvement of New Orleans Harbor, have been in session here since the 20th instant. They have carefully examined into the whole subject and are now prepared to report upon the first clause of the instructions furnished for their guidance; that is, upon the propriety of continuing operations under the present plan of improvement.

The Board are unanimously of the opinion that the object sought to be accomplished by this improvement has not been attained, and they do not think that under the present plan of operations this object can be obtained.

As the expenditures under present contracts amount to about $1,000 per day, the Board have felt justified by their instructions in recommending an immediate suspension of operations, and this decision was announced to you by telegraph to-day.

The Board will submit a preliminary report covering this portion of the subject as soon as it can be prepared, probably in the course of 10 or 12 days.

Their final report on the whole subject cannot be presented for some time, as additional surveys are imperatively needed for the preparation of reliable plans and estimates. This work will be undertaken at once, and as soon as the results are available, the Board will reconvene for the preparation of their final report.

I am, general, very respectfully, your obedient servant,

CHAS. R. SUTER,
Major of Engineers, President of Board.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., September 28, 1881.

SIR: Referring to telegram of this date, the Secretary of War has directed, in accordance with the recommendation of the Board of Engineer Officers convened by special orders No. 97 from these headquarters, that all operations for improving harbor at New Orleans, under present plan of improvement, be at once discontinued.

You will please inform the contractors whose operations are discontinued by this order that this office and the War Department will afford them all proper assistance in the adjustment of matters connected therewith.

Very respectfully, your obedient servant,

H. G. WRIGHT,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

Maj. C. W. HOWELL,
Corps of Engineers.

PRELIMINARY REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., October 5, 1881.

GENERAL: The Board of Engineer Officers, constituted by special orders No. 97, Headquarters Corps of Engineers, September 12, 1881, to examine the present condition of the work in progress for the protection of the river front of New Orleans, La., had, by your letter of instructions of September 12, 1881, two subjects presented for its consideration, viz:

1st. The question of the propriety of continuing the present plan f improvement; and,

2d. To examine anew into the subject of the improvement with a the light that the experience of the officer in charge might afford, an if found necessary, to consider and mature a new plan for the prote tion of the river front.

The Board was ordered to report its views upon the first subject "a the earliest day practicable," and upon the second "without unnec sary delay." In compliance with these instructions, the Board now ha the honor to submit its views upon the first subject, deferring its repo upon the second until additional information now in process of colle tion shall come before it. An elaborate survey of the river front wa made in 1878, under the direction of the Board of Engineers, conven by the mayor of New Orleans, but as no surveys or examinations o the locality have been made since that date, it has been thought be to have such surveys made as will show the changes which have sin occurred.

The accompanying charts, being Coast Survey Charts Nos. 7 and 8 the Mississippi River Survey, show the location of the Mississippi Riv and the direction of its flow with reference to the city of New Orlea Issuing from the straight reach above Nine Mile Point, it makes a sha bend to the right at Carrollton, then gradually curves to the left to t foot of Canal street, and then makes another sharp bend to the rig after which it follows a nearly straight line until beyond the city limi The width at Carrollton is about 2,250 feet, and the channel depth abo 140 feet, and these dimensions remain nearly uniform to about the mi dle of the gentle leftward curvature, when the width is gradually r duced and the depth increased. The former finally becomes about 1,9 feet and the latter reaches a maximum of over 200 feet, and it is in th shape that the river enters the sharp bend below Canal street, called i New Orleans the third district. The entire Mississippi River conce trated to a degree nowhere else to be found along its course, and po sessing therefore its maximum power of excavation, is here turned abo an angle of 90° upon a radius of about 3,000 feet. The concave bank meaning by that term the entire slope from the top to the bottom of t river—which can resist such a force for even a brief period must posse great stability. Rapid excavations and deep incursions are to be e pected. Yet the upper portion of this bend has been occupied by t city of New Orleans from the time of its foundation, more than a ce tury and a half ago, and the lower parts have been taken up as the ci grew, and have now been occupied for many years. There can be b one explanation of this, and that is, that the bank possesses a stabili which is truly remarkable, and that this stability has been fortified b artificial means. The few borings which have been made in the vicini indicate a formation composed of alternate layers of clay and sand. I may be that where the river intersected these layers the sand wa washed out to a considerable distance, and heavy masses of the supe posed clay fell into the voids thus created. Further washing of t sand would thus be stopped, and the bed of the river would be pr vided with a continuous coating of clay. However this may be, the fa exists that the bank is stable, and necessarily stable, from top to toe.

But as any material, even rock, will finally yield to the action of ru ning water, there has been a gradual erosion at the places where it wa to be expected, viz, in the concave bends. This has been attended b a batture formation at the points. The rate of erosion has been grea est in the Carrollton Bend, where there are no wharves and where th neighborhood is not thickly built up. It was ascertained by the Board of Engineers convened by the mayor of New Orleans, in 1877, that the bank at this place had receded about 500 feet in twenty years. While this has resulted in the loss of considerable valuable property and should be checked, the locality is of altogether secondary importance when compared with the third district. At the latter place vast commercial interests are concentrated; the bank is crowded with wharves, and every inch of the adjoining ground has a value. Here, as before stated, the bank is practically where it has been for a century and a half, or rather there has been no recession. At the extreme upper end of the bend, in the immediate vicinity of Canal street, there have been large accretions, several blocks of the city having been added and built upon outside of what was formerly the shore line. This is due to the natural movement of the bend down stream. In the bend itself considerable batture formations have occurred at intervals and then disappeared. This cannot be accounted for without a knowledge of the various obstacles, such as wharves, wrecks, &c., that may have been placed in the river at various periods—information not now attainable. It is stated that the line of the deepest water has been gradually drawing nearer to the left bank; that is, that there has been a gradual erosion of the foot of that bank. This seems highly probable, but there are not before the Board at this moment any exact data by which it can be verified. That such a movement should take place is certainly natural. What is more in need of explanation is the fact that the main bank as a whole retains its present position.

This explanation is found in the multitude of wrecked wharves and bulkheads which here line the river front. Wharf after wharf and bulkhead after bulkhead have been constructed at the top of the bank, have served their purposes for longer or shorter periods, and have then slid into the river. This has been going on for many years. There is no record of how many wharves and bulkheads have gone in at any one place, except that the number is large. In some cases a wharf has lasted but a single year. It has been reported by divers that the remains of these structures are to be found all the way to the bottom of the river, and it is easy to believe that such is the case. The piles, beams, and planks of which these structures are composed, though often held together, are twisted into irregular shapes and constitute excellent silt-catching devices. The spaces between them may readily be filled by the river at flood with sediment, much of which will be removed at low-water. The scouring power of the river can thus find employment upon its own deposits instead of upon the main bank.

But this is a very expensive means of protection, expensive not only to the owners of the wharves, but also to the commercial interests of the Mississippi Valley. The repeated destruction of the wharves has rendered high wharf rates a necessity, and has thus been the means of levying a heavy tax upon all the commerce of New Orleans, one of the first sea-ports of the United States. The series of photographs, 28 in number, herewith transmitted, show the condition of the wharves in the third district in August, 1881.

From the foregoing description it is evident that two distinct problems are presented for the consideration of the engineer: 1st. The protection of the banks from erosion, as at Carrollton and in the opposite concave bend below; and, second, the protection of the wharves from the inevitable and usually prompt destruction which has heretofore awaited them.

In the year 1877, a Board of Engineers was convened by the mayor of New Orleans to consider the subject and to report a plan for the preservation of the banks and wharves from destruction. The final report of the Board was dated April 8, 1878, and is to be found in the Annual Report of the Chief of Engineers, United States Army, for 1878, volume 1, page 614. It is under the plan therein proposed that the operations now progressing were directed to be carried on.

This plan proposed for—

The upper section of the river at Carrollton, and on the right bank above Algiers, where there are no wharves * * * to cover the slopes from a short distance above low-water to a distance out, such that all defective strata will be protected by a layer of brush formed into rafts, and ballasted with stone sufficient to keep them in position.

Along the section of the river from Morgan's wharf to the foot of Congress street, which includes the sharp bend below Canal street, above referred to, it was proposed to form a bulkhead extending the entire distance in a line with the outer row of wharf-piles by driving piles in pairs, the distance between the centers of each pair being 6 feet, and between the piles of each pair 3 feet. These piles are to be bolted together at low-water, and at the top, between the piles and extending up and down stream, brush facines are piled up to low-water mark, forming, so to speak, a brush wall. Above low-water mark, on the outside of the piles, planks are placed extending to high-water mark. From the foot of this row of piles, extending out as far as may be necessary to cover all defective strata, a layer of brush and stone in suitable form is laid upon the slope. The object in not continuing the revetment clear up to the banks, as in the other districts, is that it has been found from experience that great difficulty and expense will attend the removal of the great number of piles and timber-work now forming the wharves and occupying a portion of the slope needing protection, and which it would be necessary to remove were it determined to carpet the entire slope, adding considerably to the expense, and more than circumstances would warrant.

The width of the brush matting is not fixed in the text of the report, but in the estimate it is described as 200 feet wide. Although the term "brush" was alone used for the material of which the matting was to be composed, a variety of other materials were mentioned in the preliminary report, dated November 23, 1877, and it seems to have been the understanding that some latitude should be allowed the constructing engineer as to the selection of a material. This view would seem to be supported by the fact that the details of making the mats and placing them in position were left entirely in his hands. At all events no stress was laid upon any special quality of brush which would render it preferable to other materials for application in this case. The use of a different material, if worked up in such shape as would carry out the spirit of the plan, could not be regarded as a departure from the plan.

Operations have been carried on during the low-water seasons of 1878, 1879, 1880, and 1881, the work for the first three years being confined to the third district, while the greater portion of the work done this year is in Carrollton Bend. The following is the method of construction adopted for the former district. The mat was first made in small sections 24 feet by 25 feet, the material used being cane. In the finished section the canes lay in a single layer, side by side, with sufficient interval between them to allow for the stitching, say 1 inch. It was sewed from one end to the other by seven continuous pairs of wires or pieces of marline, the latter being used to the exclusion of wire after the first few mats were placed. The stich was the shoemaker's stitch; that is, one marline passing under one cane, passed over the next, under the third, over the fourth, and so on, while the other marline of the same pair alternated in the same manner, but passing on the opposite sides of the canes. The marlines thus crossed each other at each interval between the canes. In crossing they were not caught together. They were secured only to the middle and end canes of the section. The breaking of a marline at one point destroyed its efficiency throughout its length. An opening was made in each joint of each cane to destroy its buoyancy and admit sediment from the river after sinking. Eight of these small sections were sewed together, end to end, making a mat 200 feet by 24 feet, and it was in this shape that the mats were put down during the seasons of 1878 and 1879. For placing them, a row of guide piles 6 feet apart were driven upon the line of the front wharf piles. These were heavy piles of pine 65 feet long, and were intended to subsequently form part of the brush wall described in the plan. An iron ring was slipped over each pile, fitting loosely, to which the end of the mat, the 24-foot side, was secured by a piece of light rope. The barge upon which the mat was spread was then moved out into the stream by a tug-boat, the mat was launched and placed upon the bottom, with its longer side as nearly as possible perpendicular to the shore. The ballast used with the first few mats was old boiler-tubes, and afterwards sand-bags. Buoys were attached to each mat before sinking, by means of which its location upon the bottom could afterwards be approximately ascertained. The drawing upon which these maps are represented, a copy of which is inclosed, shows much irregularity in their sinking. Care was taken to sink a new mat at any place which seemed to have been left uncovered, but, notwithstanding this precaution, it is probable that some portions of the slope within a distance of 200 feet were left uncovered. The presence of ships at the wharves was a serious inconvenience to the work, causing frequent interruptions. It could not be made continuous. The work done in 1878 and 1879 was begun just below Picayune Pier and extended to the foot of Mandeville street, covering a length of 1,116 feet measured along the bank. It consisted entirely of matting of the above description, nothing being done towards the brush wall except the piling.

In resuming operations in 1880 it was found impossible to begin at Mandeville street, where the work of 1879 terminated, because of the number of ships moored below, as many as 20 sometimes lying between Mandeville and Montegut streets. These the wharf-master refused to move. Work was accordingly begun at Montegut street, leaving a gap of 2,262 feet between that and the work of 1879. The general construction of the mats was the same as before, except that they were made larger. Forty sections, each 14 feet by 25 feet, were sown together, making a mat 200 feet by 70 feet, instead of 200 feet by 24 feet, as before. Floating ways, having the direction of their slope parallel to the shore instead of perpendicular to it, as before, were moored to the guide-piles. The mat, being secured to the latter in the same manner as before, was launched up and down stream instead of across stream, as before. Ten such mats, covering a length of 560½ feet of bank between Montegut and Louisa streets, were laid in 1880. The drawing representing their position on the bottom, a copy of which is inclosed, shows irregularity in their location, but less than in the case of previous work. The ballast used was sand-bags.

The work of 1881 in this vicinity has made but little progress. Two mats similar to those of 1880 had been laid at the time of the visit of the

Board, and the floating ways were blocked from further progress downstream by the presence of a large ship engaged in loading at the only wharf remaining available in the third district. It was stated also that some of the guide-piles driven in advance of the matting were being pulled up by the wharf contractor, as they interfered with the movements of his pile-drivers engaged in reconstructing the wharves. At Carrollton, however, there being no obstructions either above or below the water surface, the work was being pushed with great rapidity, the character of it being precisely similar, piles and all, to that above described for the the third district during the year 1880.

The wharves in front of which the work of 1878 and 1879 was done fell into the river in the spring and summer of 1880. They were rebuilt and were wrecked again in 1881. Their condition in August last is shown upon those of the photographs which are numbered from 1 to 7. The wharves in front of which the work of 1880 was done have been destroyed this year. Their condition in August is shown upon photographs 15 to 21, inclusive. The oldest of the work in Carrollton Bend has been down but a few weeks, and has received no further practical test.

It is plain that the plan of improvement as executed, so far at least as the third district is concerned, is a failure. The impossibility of doing continuous work, and the flimsy character of the matting put down, would perhaps account for this. Under any plan a remedy for the first evil consists in withdrawing the portion of the river front under improvement from wharf service while the work is going on, and this requires the co-operation of the city authorities. The cane is not, in the opinion of the Board, a good material for the protection of the banks of the Mississippi. Its straightness and smoothness deprive it, to a large degree of the silt-catching quality which is of so great importance in the revetment of the banks of this river. A mattress made of cane receives little if any, re-enforcement from the deposits of the river. If this materia be used the mattress should be fabricated with great care, all its fastenings should be made substantial, and if it be found impracticable by an disposition of the material to procure an artificial roughness, it shoul be prepared to resist by its own strength all the forces which may b brought to bear against it. This has not been done, and in the opinio of the Board the mats, as constructed, do not form a protection as efficient as the one contemplated in the plan.

While the method of construction has been defective, and the circumstances of carrying on the work have been singularly difficult, it is th opinion of the Board that no better results would have been attained i the third district if both these causes of failure had been wanting. Th problem here seems to be one of wharf protection rather than of ban protection, though the latter question appears in the background.

The root of the principal evil—the repeated destruction of the wharves—seems to lie in the construction of the wharves themselves. The bearing piles, fender piles and mooring piles alone obstruct the flow of the water and cause deposits. When to these are added the remains of old wharves, old broken and settled piles, and old bulkheads, a collection of obstacles is found near the top of the bank which, for efficiency in causing silt deposits, could hardly be excelled if designed for that purpose. Heavy deposits are made among them and between the wharves during the higher stages of the river when it is charged with sediment. This mass of soft material acquires in time a bulk and weight which the steep slope below cannot support, even while it remains submerged. When the river falls the new deposits are often uncovered, and the tendency to rupture is increased by the withdrawal of the support furnished by he water. The difficulty is aggravated by the presence of vessels. Vessels lying at the ends of the wharves deflect the current downwards owards the bottom, and while preventing deposits at that place cause a scour upon the material below. The deeper the draught of the vessel the deeper will this action extend. A vessel drawing 25 feet will, f left long enough at one spot in a rapid current, deepen the water by an amount nearly equal to its draught. Here are all the conditions necessary to explain the various phenomena which accompany the destruction of the wharves. The slope of the bank being too steep to bear the great additional weight at the top of it, yields, and may yield in a variety of ways. The new material may slide out, carrying the upper parts of the piles with it, and leaving the toes undisturbed; in this case the piles will be inclined outwards. Or it may settle down vertically, pushing out a layer of similar material from beneath it. If the latter layer is within the range of the piles it will carry their toes out, and in this case the piles will be inclined inwards; if it is beyond the range of the piles these will simply sink and not be inclined either way. In the disintegration attending these disruptions a crack may be formed into which a pile will sink of its own weight, and, tearing loose from its cap, will settle down with greater rapidity than the balance of the wharf. A combination of the two movements above described, or unequal loading of the wharf, or an eddy about its extremity, or the unequal stability of different portions of the soil underlying the fresh deposits, will account for the irregularities which sometimes appear in the wreck of a single wharf. The yielding of the bank may occur at any stage of water, though it is most usual immediately after the fall from a high stage, and is rare immediately after a prolonged low stage. The increased draught of the sea-going ships now visiting New Orleans would cause more rapid wrecking of their wharves than formerly. While the presence of vessels at the ends of the wharves aids and hastens their destruction, it is, as before stated, not essential to it.

How far down this sloughing of the bank extends is not now known, and it can be ascertained only by careful and prolonged observation. It would seem probable that the depth is not great, not exceeding perhaps a depth of 40 or 50 feet. But whatever the depth, a preliminary to any efficient protection must be the removal of the primary cause of the sloughing, viz, the overloading of the top of the bank by silt deposits. The brush wall proposed in the plan under discussion would have the contrary effect. It would increase the amount of this overloading, and would aggravate the evil.

The Board is therefore forced to the conclusion that the present plan of improvement, whether viewed in outline, as to its general merits, or in detail, as to its method of execution, should not be continued.

CHAS. R. SUTER,
Major of Engineers, President of Board.
W. H. H. BENYAURD,
Major Engineers.
AMOS STICKNEY,
Major of Engineers.
O. H. ERNST,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

FINAL REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., February 20, 1882.

GENERAL: The Board of Engineer Officers, constituted by Special Orders No. 97, Headquarters Corps of Engineers, September 12, 1881, to examine and report upon the subject of the protection of the river front of New Orleans, has now completed the duties prescribed in your letter of instructions of September 12, 1881.

In a preliminary report, dated October 5, 1881, the Board gave a general description of the physical conditions existing at New Orleans and of the plan of improvement then in process of execution, and recommended that that plan be discontinued. For a full explanation of these points attention is invited to that report. Since that date numerous cross-sections of the river in Carrollton Bend and in the third district have been re-sounded. The accompanying map, plate I, shows the location of these sections. The cross-sections themselves as found by the survey of 1878 and again in 1881 are shown upon the sheet of sections, plate II. Besides these cross-sections lines of soundings have been run out at short intervals in the third district, giving profiles of the left bank of the river to a short distance beyond the ends of the wharves. These profiles and those taken upon the same lines in 1878 are shown upon plate III.

A comparison of the sections and profiles fully confirms the conclusions of the Board given in its preliminary report. These were that the banks of the river in the vicinity of New Orleans are stable; that in the concave bends there is a slow and gradual erosion at places where the stability of the bank has not been re-enforced by the remains of old wharves and bulkheads; that the frequent wrecking of the wharves is due not to the erosion of the bank but to the sloughing of the silt deposited among the wharves at high-water where these are located upon a steep slope.

The sections show that no important changes have occurred in the bed of the river since 1878. Near the top of the left bank in the third district changes are shown, being in most cases a fill. The third district being crowded with wharves, the changes here are to be attributed to the deposit and sloughing of silt. The preponderance of the fill is explained by the higher stage at which the recent soundings were taken.

As stated in the preliminary report, there are presented in the river front of New Orleans two distinct problems, viz:

1st. The protection of the wharves; and,

2d. The protection of the bank from erosion.

The first problem appears principally in the third district. At this locality the more recent examinations of the Board show that the stability of the bank is so great that no further protection seems necessary below low-water line. Above that line the slope as far up as the line of bulkheads is now protected by the presence of the wharves, and still further up is partially protected by the bulkheads themselves, which will be referred to below.

For the protection of the wharves there seem to be three alternatives, viz: 1st, to so construct them that they shall not cause heavy silt deposits; or, 2d, to make them strong enough to withstand the strains brought to bear upon them by the sloughing; or, 3d, to gradually remove the deposits by artificial means before they have had an opportunity to slip in mass. The first remedy may be accomplished by providing floating instead of fixed supports. The second would require a form of construction much more substantial than any heretofore used at this locality, and would be experimental. The third is easily accomplished if it be kept in view when the wharves are constructed.

A powerful tug presents probably the easiest and quickest means of removing large masses of silt. The disturbance caused by the motion of her wheel will effect an excavation at a considerable distance, and will be effective at the greatest distance which will be necessary in this case. Openings between the wharf-heads should be left for the admission of such a tug, and as soon as the deposits have acquired any considerable volume, and before the river has begun to fall from its high stage, she should be set at work within the wharves and between the piers leading to them. By this means the pressure of the silt may be prevented from becoming excessive.

As an additional precaution, greater care should be exercised in placing the piles which support the wharves. Fewer piles should be used, and these should be heavier than those now used, and should be driven to much greater depth. The wharves, in many cases, seem to have been constructed with the conviction that it was impossible to make them durable, and the cost of their construction has been kept as low as possible. Piles have been driven, as a rule, to a depth of about 12 or 15 feet, and never, so far as the Board can learn, to a depth greater than 25 feet. This depth should be increased to about 40 feet.

In some instances the wrecking of the wharves has been attended by the destruction of the wooden revetment in their rear, called a bulkhead. This revetment or bulkhead protects the levee from surface wash, and holds its outer surface at a steep slope. It does not extend down low enough to be beyond the influence of the sloughing mass in front of and under it, and its destruction frequently involves danger to the levee behind it. If the fixed supports of the wharves should be replaced by floating supports, these bulkheads would be still more exposed. To give them greater security they should be built up from a lower level, and should be more securely tied into the bank, external braces being abandoned. In case floating wharves are introduced, a light matting of brush, about 30 feet wide, should be laid outside the bulkheads on the bottom. Their slope might to advantage be reduced.

In Carrollton Bend the problem of bank protection alone is presented. The observations of the Board show that no great changes have occurred here since 1878, but as considerable erosions took place in the twenty years preceding 1878, and as there is no re-enforcement by artificial means of the natural stability of the bank, it seems desirable that a revetment should be constructed. An examination of the cross-sections shows a very gentle slope between high-water and low-water marks. The soil is composed largely of clay. It is thought that this portion of the slope may be safely left unprotected until after the revetment of the portion below, and that then it will be safe to advance the bulkhead and levee to a line about 30 or 40 feet from low-water mark, thus reclaiming a considerable quantity of valuable land. This space, 30 or 40 feet wide, between the new bulkhead and the present low-water mark may then be protected with a layer of riprap. To be efficient, the protection of the slope below the low-water line should extend to the bottom of the river. This will require a mattress about 400 feet wide. It is essential that every portion of this surface should be covered, and to insure this the mattress, when in place, should be continuous, either by an absolutely continuous construction, making one single mattress for the entire length of the bend, or by the thorough overlapping of contiguous sections, which should be made of the greatest practicable length. The mattress should be made of brush, the material being so adjusted as to possess the greatest silt-catching power. It should be substantial, and should be ballasted with stone. While the Board believes that such a mattress is practicable, it is aware that its magnitude is unprecedented, and that many contingencies may arise which will alter details of construction first employed, and which will modify the cost. It is of the opinion that much latitude should be allowed the constructing engineer in arranging the details, and that for this reason he should execute the work, at least for one season, by hired labor, and not by contract.

The estimate of cost is placed at 7 cents per square foot, or $28 per running foot of bank. This estimate is based upon the cost of bank protection as executed elsewhere in this country, allowance being made for the greater difficulties to be anticipated in the construction and for the increased cost of the materials in this locality; but as this allowance is not the result of exact data, the estimate must be regarded only as an approximation. The total length of bank in Carrollton Bend is about 10,000 feet. At $28 per foot the estimated cost will be $280,000.

The right bank of the river below Carrollton Bend, for a length of about 7 miles, presents at different places the problems of both bank protection and wharf protection, but the evils are in both cases much less than at the localities already considered. The remedies are the same, and that for wharf protection is as easily provided. The wharves, however, are few.

The remedy which will eventually be required for the greater part of the entire length of 7 miles is a protection of the bank. This does not seem to the Board to be necessary at this time, and in consideration of the better information, both as to cost and as to details of construction, which will result from the work proposed for Carrollton Bend, it respectfully recommends that operations on this part of the river be for the present postponed.

It is the opinion of the Board that no work should be undertaken upon the river front of New Orleans until such action shall be taken by the city authorities as will give to the United States during the execution of the work entire control of the portion of the front upon which operations are being carried on. To leave these exposed to interruption by shipping, by wharf contractors, or other obstacles, will seriously diminish their chances of success.

CHAS. R. SUTER,
Major of Engineers,
President of Board.
W. H. H. BENYAURD,
Major of Engineers.
AMOS STICKNEY,
Major of Engineers.
O. H. ERNST,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

M 2.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, FROM JACKSON TO CARTHAGE.

This work originated from an examination provided for by Congress in the river and harbor act of 1878, a report of which, with plan and estimate of cost of improvement, was published in the Report of the Chief of Engineers for 1879, Appendix K 2.

In the river and harbor act approved March 3, 1879, an appropriation of $6,000 was made for commencing the work, and under date of November 20, 1879, after due advertisement, &c., contract was entered into with J. S. Hamilton & Co., under this appropriation, for improving certain specified portions of the river, which would afford relief to a certain extent in opening navigation between Jackson and Carthage with a rise of 5 feet. Owing to high water but little work was done during the fiscal year ending June 30, 1880, and it was not until March 14, 1881, that the contractors reported the work completed. Assistant Engineer Collins was at once ordered to make the necessary inspection before settlement could be effected. His report was to the effect that the work had not been properly done as required by the specifications and articles of agreement, and could, therefore, not be accepted by the United States.

The contractor was duly notified of this fact (Report of Chief of Engineers, 1881, Appendix M 2). Again, under date of December 11, 1881, the contractors reported the work completed, but the inspector who was sent up shortly afterwards found the river too high for anything like a proper examination. This work will be inspected as soon as the river reaches a proper stage.

By act of Congress approved June 14, 1880, $7,500 were appropriated for continuing this work, and under date of October 12, 1881, articles of agreement were duly entered into with J. S. Hamilton, he having been the lowest responsible bidder for improving 51 miles of the river up stream from Jackson. The amount for which he contracted to do this work was $7,000.

It is not known how far the contractor has advanced, as he has not as yet asked for an inspection, or reported how near the work is to completion.

In the river and harbor act approved March 3, 1881, further provision was made for this work to the amount of $2,500. A project was submitted to the Chief of Engineers providing for the continuation of the work being done under previous appropriations. This project was approved and the work duly advertised, but no bids were received (Report of Chief of Engineers, 1881, Appendix M 2), and it was therefore recommended that the amount, $2,500, be allowed to await further appropriation.

In the river and harbor bill for 1882 $2,500 additional were appropriated.

The failure in the prosecution of this work by contract being now fairly demonstrated, I have proposed in project submitted August 17, 1882, to continue the work by hired labor.

The original estimate for this improvement was $21,000. Of this amount $18,500 have already been appropriated, leaving $2,500 to complete the work as originally estimated for. It is recommended that this amount be appropriated for the fiscal year ending June 30, 1884.

The work is not considered permanent, as the obstructions caused by logs, snags, and drift are liable to reform at any time, owing to caving banks, carrying trees, &c., into the stream.

The work is located in the collection district of New Orleans and the nearest light house is on the Rigolets, opposite the mouth of West Pearl River.

Original estimated cost	$21,000 00
Total amount appropriated	18,500 00
Total amount expended	601 66

Money statement.

July 1, 1881, amount available	$15,584 86
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	186 52
July 1, 1882, amount available	15,398 34
Amount appropriated by act passed August 2, 1882	2,500 00
Amount available for fiscal year ending June 30, 1883	17,898 34
Amount (estimated) required for completion of existing project	2,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	2,500 00

M 3.

IMPROVEMENT OF PEARL RIVER, BELOW JACKSON, MISSISSIPPI.

This work originated in an examination authorized by act of Congress approved June 18, 1878, a report of which, together with plan and estimate of cost of improvement, was published in Report of the Chief of Engineers for 1879, Appendix K 2.

By act of Congress approved June 14, 1880, the sum of $30,000 was appropriated for its commencement.

The project for expenditure of this amount having been approved by the Chief of Engineers, the work was duly advertised, and bids received and opened August 30, 1880.

The contract was awarded Seth N. Kimball, of Mobile, the lowest bidder, and articles of agreement entered into October 7, 1880, and approved November 15, 1880 (see Report of Chief of Engineers for 1881, Appendix M 3). Owing to high-water, the contractor was unable to complete his work within the time specified in the contract, to wit, January 1, 1882, and on December 29, 1881, made official application to have the time for completion extended to July 1, 1882, requesting also that the work reported as finished by him be inspected, and, if found satisfactory, be accepted by the government. The application for extension of time was approved by the Chief of Engineers, but no inspection or acceptance of any part of the work on the part of the government was authorized until the whole should be completed.

Under date of February 2, Mr. Kimball made application for modification of the terms of his contract in regard to partial payment before completion of entire work. This was forwarded to the Chief of Engineers with an adverse indorsement, and was disallowed. Since that time but little work has been done, on account of continued high-water. June 3 the contractor reported that 104 miles of river, from Jackson down, had been completed, leaving 91 miles yet to be cleared; and on the 7th, finding that he could not finish the work by July 1, he made application for a further extension of six months within which to complete the remaining work, which was granted by the Chief of Engineers on account of the continued high stage of water in the river.

As matters now stand, the work is to be finished by January 1, 1883.

By act of Congress approved March 3, 1881, further provision was made for this work to the amount of $25,000, and a project for its expenditure was submitted to the Chief of Engineers, and by him approved (see Report of Chief of Engineers for 1881, Appendix M 3).

After due advertisement bids were opened July 30. The following is an abstract of bids received:

Numbers of proposals.	Names of bidders.	Amount per mile for removal of obstructions.	Time of commencing work.
1	Jno. Maguire	75½ miles, at $331.12	Within four months, stage of river permitting.
2	Carl. P. Seymer	82 miles, at $304.87	
3	Jno. Tobias	55 miles, at $140; balance, $940	
4	G. A. Meyer	105 miles, at $238.09½	
5	C. I. Fayssoux	64 miles, at $390	
6	V. Wehrmann	55 miles, at $145; balance, $890	
7	S. N. Kimball	$286.14⅔	

Gustavus A. Meyer being the lowest responsible bidder, the contract was awarded him, and articles of agreement entered into under date of September 21, 1881.

The following is the body of the agreement:

This agreement witnesseth that, in conformity with the advertisement and specifications hereunto attached, and which form a part of this contract, the said Charles W. Howell, for and in behalf of the United States of America, and the said Gustavus A. Meyer, for himself, his heirs, executors, and administrators, have mutually agreed, and by these presents do mutually covenant and agree to and with each other as follows, viz:

That the said party of the second part, in accordance with advertisement and specifications above referred to, and in accordance with his proposal, herewith attached, shall faithfully perform the work of improving the navigation of Pearl River, Mississippi, from the end of the 195th mile below the railroad bridge at Jackson, for a continuous distance down said Pearl River of 100 miles, in every particular as specified.

That the said party of the first part, for and in consideration of the faithful performance of this specified work by the said party of the second part, and after its due acceptance as provided for, agrees to pay to the latter the sum of $23,809.50.

Owing to high-water it was not until March 15 that the contractor gave notice that he was about to commence work.

On June 1 he reported that 80 of the 100 miles covered by the contract had been completed, and at this date the work is reported finished by the contractor.

By act of Congress passed August 2, 1882, an additional appropriation of $15,000 was made for continuing the improvement.

The original estimate of the cost of improving the river from Jackson to its mouth was $95,940. Of this amount $70,000 has been appropriated, and it is recommended that the balance, $25,940, required to complete the work according to the original estimate, be appropriated for the fiscal year ending June 30, 1884.

The improvement is not considered a permanent one, as the obstructions caused by trees, logs, and snags are liable to reform at each high-water, so that the services of a snag-boat will probably be required for some time of each year to keep the channel clear.

The commercial importance of the river was indicated in the report of examination.

The work is located in the collection district of New Orleans. The nearest light-house is at the Rigolets opposite the mouth of West Pearl River.

Original estimate	$95,940 00
Total amount appropriated	70,000 00
Total amount expended	2,075 08

Money statement.

July 1, 1881, amount available	$53,807 80
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	882 88
July 1, 1882, amount available	52,924 92
Amount appropriated by act passed August 2, 1882	15,000 00
Amount available for fiscal year ending June 30, 1883	67,924 92
Amount (estimated) required for completion of existing project	25,940 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	26,000 00

M 4.

IMPROVEMENT OF AMITE RIVER, LOUISIANA.

This work originated in an examination authorized by act of Congress approved March 3, 1879, a report of which, together with plan and estimate of cost of improvement, was published in Report of Chief of Engineers for 1880, Appendix M.

By act of Congress approved June 14, 1880, $8,000 were appropriated for its commencement. The contract under this appropriation, covering 40 miles above junction with Bayou Manchac, was let to H. E. Glasscock. (See Report of Chief of Engineers for 1881, Appendix M 4.)

At the beginning of the fiscal year 6½ miles had been reported cleared. The work, according to reports of the contractor, progressed slowly from this time until November, when high-water intefered, and since that time the same reason for delay has been frequently advanced.

By act of Congress approved March 3, 1881, an appropriation of $5,000 was made for continuing the work.

Advertisements were duly published in the proper papers inviting proposals, but at the time for opening same, July 30, none had been received. Some time afterwards two bids were received and submitted to the Chief of Engineers. That of Mr. W. G. Mitchell being considered the more favorable to the United States, was accepted and articles of agreement signed October 17, 1881. Here the matter rested, as Mr. Mitchell continued to delay furnishing the proper bonds, despite the fact that he was notified to do so, until June 7, 1882, when recommendation was made to the Chief of Engineers that the contract be set aside and the work readvertised. This recommendation having been approved, Mr. Mitchell was notified of the fact, and after due advertisement, proposals were opened August 9, 1882. Contract has not yet been awarded.

The original estimate for this work was $23,760, or $10,760 more than the amount appropriated, and it is therefore recommended that an appropriation of $10,760 be made for the fiscal year ending June 30, 1884, for completion of the improvement.

The commercial importance of the river was indicated in the report of the examination.

The improvement is not considered a permanent one, as the obstructions are liable to reform.

The work is located in the collection district of New Orleans, and the nearest lighthouse is at the mouth of Pass Manchac.

Original estimated cost	$23,760 00
Total amount appropriated	13,000 00
Total amount expended	302 26

Money statement.

July 1, 1881, amount available	$12,845 73
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	147 99
July 1, 1882, amount available	12,697 74
Amount (estimated) required for completion of existing project	10,760 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	10,800 00

M 5.

IMPROVEMENT OF VERMILLION RIVER, LOUISIANA.

This work originated in an examination authorized by act of Congress approved March 3, 1879, a report of which, together with plan and estimate for improvement, was published in the Report of Chief of Engineers for 1880, Appendix M 12.

By act of Congress approved June 14, 1880, an appropriation of $5,000 was made for commencement of work. The contract under this appropriation was let to G. A. Meyer, and articles of agreement entered into under date of February 15, 1881. The distance to be improved was 22 miles downstream from the Railroad Bridge. (Report of Chief Engineers, 1881, Appendix M 5.)

Owing to high-water, work was not commenced until July, 1881. It was completed September 3, 1881, and after inspection on the part of the government the contractor was paid in full on September 13, 1881.

By act of Congress approved March 3, 1881, $4,900 were appropriated for completion. Under this appropriation bids were received and opened July 30, 1881.

The following is an abstract of the bids:

Numbers of proposals.	Names of bidders.	For construction of dam as specified.	Amount per mile for removal of obstructions.	Time of commencing work.
1	Jno. Maguire	$2,166 00	29 miles, at $92 00	Within three months.
2	G. A. Meyer	2,000 00	29 miles, at 100 00	

Mr. John Maguire being the lowest responsible bidder, the contract was awarded him, and articles of agreement entered into accordingly, under date of September 17, 1881.

The following is the body of the agreement:

This agreement witnesseth, that, in conformity with the advertisement and specifications hereunto attached, and which form a part of this contract, the said Charles W. Howell, for and in behalf of the United States of America, and the said John Maguire for himself, his heirs, executors, and administrators, have mutually agreed, and by these presents do mutually covenant and agree, to and with each other, as follows, viz:

That the said party of the second part, in accordance with his proposal hereunto attached and the advertisement and specifications above referred to, shall faithfully perform the work of closing the eastern entrance to the cove through which Vermillion River runs before reaching Vermillion Bay, by a brush dam, in every particular as specified; and shall also faithfully perform the work of improving the navigation of Vermillion River for a distance of 27¼ miles continuously downstream, commencing at a point 22 miles below the Railroad Bridge.

That the said party of the first part, in consideration of the faithful performance of these specified works by the said party of the second part, and after their due acceptance, agrees to pay to the latter the sum of $4,696, *i. e.*, $2,166 for the dam, and $2,530 for the river improvement, being 27½ miles at the rate of $92 per mile, but no payment shall be made until both works are completed.

The contractor has reported that high-water prevented commencement of work until after the close of the fiscal year. Since then, however, work has been commenced.

The improvement is not considered of a permanent character, except so far as the dam at the mouth of the river is concerned, because the obstructions in the stream are liable to reform at any time.

No additional appropriation is required. The commercial importance of the river was indicated in the report of examination.

The work is situated in the collection districtof New Orleans, and the nearest lighthouse is at the entrance of Atchafalaya Bay.

Total amount appropriated	$9,900 00
Total amount expended	5,172 32

Money statement.

July 1, 1881, amount available	$9,786 46
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	5,058 78
July 1, 1882, amount available	4,727 68

M 6.

IMPROVEMENT OF TANGIPAHOA RIVER, LOUISIANA.

This work originated in an examination authorized by act of Congress approved June 18, 1878, a report of which, together with plan and estimate for improvement, was published in the Report of the Chief of Engineers for 1879, Appendix K 14.

By act of Congress approved June 14, 1880, an appropriation of $5,000 was made for its commencement.

After advertisement, &c., in due form, the contract under this appropriation was awarded to Carl P. Seymer, the articles of agreement specifying that he should clear the river and its banks of obstructions, according to specifications attached to contract, for a distance of 34 miles upstream from the mouth of the river, for $4,750. (Report of the Chief of Engineers for 1881, Appendix M 6.)

The contractor begun the work May 2, 1881, and completed it November 4, 1881.

On November 15 the assistant engineer who inspected the work reported that the articles of agreement, &c., had been complied with by the contractor, and accordingly he was paid the amount due him November 21, 1881.

By act of Congress approved March 3, 1881, further provision for this work was made to the amount of $2,000. A project for its application was submitted to the Chief of Engineers, and after its approval the work was duly advertised and the only bid received opened July 30, 1881. This bid was by Carl P. Seymer, who proposed to improve the 6 miles of river above the point where work under the previous contract stopped, for $2,000. As this bid was considered excessive by the Engineer officer in charge, it was rejected by the Chief of Engineers, and the money held to await further appropriations.

The improvement is not considered permanent, as the obstructions caused by trees, logs, snags, and drift are liable to reform.

The commercial importance of the work was indicated in the report of survey.

The original estimate of cost of improvement was $10,700. The amount appropriated is $7,000, and it is recommended that $3,700 be appropriated to complete the work.

The work is situated in the collection district of New Orleans. The nearest lighthouse is at the mouth of Pass Manchac.

Original estimate	$10,700 00
Total amount appropriated	7,000 00
Total amount expended	5,008 99

Money statement.

July 1, 1881, amount available	$6,843 91
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	4,852 90
July 1, 1882, amount available	1,991 01
Amount (estimated) required for completion of existing project	3,700 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	3,700 00

M 7.

IMPROVEMENT OF TCHEFUNCTE RIVER, LOUISIANA.

This work originated in an examination authorized by act of Congress approved March 3, 1879, a report of which, together with plan and estimate of cost, was published in the Report of the Chief of Engineers for 1880, Appendix M.

By act of Congress approved March 3, 1881, an appropriation of $1,500 was made for its commencement, and under date of April 30, 1881, a project for application of this amount was submitted to the Chief of Engineers. This having been approved, the work was duly advertised, and bids received and opened July 30, 1881.

The following is an abstract of those received:

Abstract of bids received for improving Tchefuncte River, Louisiana.

Numbers of proposals.	Names of bidders.	Amount per mile for removal of obstructions.	Time of commencing work.
1	C. E. Cate	Whole distance for $725	As soon after award of contract as season will allow.
2	William Fagan	$100 per mile.	

William Fagan being the lowest responsible bidder the contract was awarded him, and articles of agreement entered into October 5, 1881, and approved by the Chief of Engineers October 13, 1881.

The following is the body of the agreement:

This agreement witnesseth that in conformity with the advertisement and specifications hereunto attached, and which form a part of this contract, the said Charles W. Howell, for and in behalf of the United States of America, and the said William

Fagan, for himself, his heirs, executors, and administrators, have mutually agreed, and by these presents do mutually covenant and agree to and with each other as follows, viz:

That the said party of the second part, in accordance with his proposal hereunto attached, and the advertisement and specification above referred to, shall faithfully perform the work of improving the navigation of Bogue Falaya from its mouth in the Tchefuncte River, to Covington, La., a distance of 4 miles, as shown by chart of survey, in every particular as specified.

That the said party of the first part, in consideration of the faithful performance of this specified work by the said party of the second part, agrees to pay to the latter the sum of $400.

Owing to high-water, work was not commenced until May, 1882. In the latter part of the month its completion was reported by the contractor, and accordingly an inspector was sent to examine it, and upon his reporting that the specifications had been complied with payment was made in full to contractor on June 8, 1882.

By act of Congress passed August 2, 1882, $1,500 were appropriated for continuing the improvement.

The original estimate for the work was $5,460, and it is recommended that $2,460 be appropriated for the fiscal year ending June 30, 1884.

The commercial importance of the river was indicated in the report of examination.

The improvement is not considered a permanent one as the obstructions are liable to reform.

The work is located in the collection district of New Orleans. The nearest light-house is near Madisonville, on the river.

Original estimate	$5,460 00
Total amount appropriated	3,000 00
Total amount expended	457 76

Money statement.

July 1, 1881, amount available	$1,500 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	457 76
July 1, 1882, amount available	1,042 24
Amount appropriated by act passed August 2, 1882	1,500 00
Amount available for fiscal year ending June 30, 1883	2,542 24
Amount (estimated) required for completion of existing project	2,460 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	2,500 00

M 8.

IMPROVEMENT OF TICKFAW RIVER, LOUISIANA.

This work originated in an examination authorized by act of Congress approved March 3, 1879, a report of which, together with plan and estimate of cost, was published in Report of Chief of Engineers for 1880 (Appendix M).

By act of Congress approved March 3, 1881, an appropriation of $2,000 was made for its commencement.

A project was submitted under date of April 30, 1881, to the Chief of Engineers for application of this amount, and having been approved by him, advertisements inviting proposals were duly published, and bids opened July 30, 1881.

The following is an abstract of those received:

Numbers of proposals.	Names of bidders.	Amount per mile for removal of obstructions.	Time of commencing work.
1	C. E. Cate	17 miles up from mouth, for $2,000	As soon after award of contract as condition of river will allow.
2	William Fagan	16 miles at $80; balance at $210.	

The bid of Mr. William Fagan being the lowest, the contract was awarded him, and articles of agreement entered into October 5, 1881, and approved by the Chief of Engineers under date of October 25, 1881. The following is the body of the agreement:

This agreement witnesseth that, in conformity with the advertisement and specifications hereunto attached, and which form a part of this contract, the said Charles W. Howell, for and in behalf of the United States of America, and the said William Fagan, for himself, his heirs, executors, and administrators, have mutually agreed, and by these presents do mutually covenant and agree, to and with each other as follows, viz:

That the said party of the second part, in accordance with his proposal hereunto attached, and the advertisement and specifications above referred to, shall faithfully perform the work of improving the navigation of the Tickfaw River, Louisiana, for a continuous distance 18½ miles up said river from its mouth, in Lake Maurepas, Louisiana, as shown by chart of survey in every particular as specified.

That the said party of the first part, in consideration of the faithful performance of this specified work by the said party of the second part, agrees to pay to the latter the sum of $1,805.

Work under the contract was commenced January 4, 1882, but owing to high-water was very soon after suspended, and nothing further done until the month of June following. At the close of the fiscal year, 16 miles of the river had been cleared, and since then has been completed and paid for.

By act of Congress passed August 2, 1882, an additional appropriation of $2,000 was made, leaving $6,230 yet to be appropriated to complete the work according to the original estimate, which was $10,230.

The improvement is not considered a permanent one, as the obstructions are liable to reform at any time.

The work is located in the collection district of New Orleans. The nearest lighthouse is at the mouth of Pass Manchac.

Original estimate	$10,230 00
Total amount appropriated	4,000 00
Total amount expended	84 74

Money statement.

July 1, 1881, amount available	$2,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	84 74
July 1, 1882, amount available	1,915 26
Amount appropriated by act passed August 2, 1882	2,000 00
Amount available for fiscal year ending June 30, 1883	3,915 26
Amount (estimated) required for completion of existing project	6,230 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	6,300 00

M 9.

IMPROVEMENT OF BAYOU TECHE FROM SAINT MARTINSVILLE TO PORT BARRE, LOUISIANA.

This work originated in an examination authorized by act of Congress approved March 3, 1879, a report of which, together with plan and estimate, was published in Report of Chief of Engineers for 1880 (Appendix M).

By act of Congress approved June 14, 1880, an appropriation of $6,000 was made for its commencement. (Report of Chief of Engineers, 1880, Appendix M 8.)

A project for application of this amount was submitted to the Chief of Engineers, and having been approved the work was duly advertised and bids received and opened August 30, 1880. G. A. Meyer being the lowest bidder, the contract was awarded him. This contract was for clearing the bayou and its banks from Leon's Bridge to Saint Martinsville, and the work under it was completed during the month of June, 1881. (See Report of Chief of Engineers for 1881, Appendix M 9.) By act of Congress approved March 3, 1881, further provision was made for this improvement by an appropriation of $20,000, and under date of April 30, 1881, a project for its application was submitted to the Chief of Engineers, and by him approved under date of May 12, 1881. (See Report of Chief of Engineers, 1881, Appendix M 9.) As this project included the location and construction of a lock and dam, further examination and data were needed before exact location and detailed plans, &c., could be made. It was proposed to make this survey during the low-water of last season. This, however, was not done, but will be commenced soon.

The improvement is considered as permanent in the ordinary acceptance of the term as applied to works of this character.

The original estimate for this work was $56,690, and of this amount $26,000 have been appropriated, leaving $30,690 to complete the work according to the original estimate. It is recommended that this amount be appropriated for the fiscal year ending June 30, 1884.

The work is located in the collection district of New Orleans. The nearest light-house is at the entrance to Atchafalaya Bay.

Original estimate	$56,690 00
Total amount appropriated	26,000 00
Total amount expended	6,535 35

Money statement.

July 1, 1881, amount available	$20,132 66
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	668 01
July 1, 1882, amount available	19,464 65
Amount (estimated) required for completion of existing project	30,690 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	31,000 00

M 10.

IMPROVEMENT OF BAYOU TECHE BY CONNECTING SAME WITH GRAND LAKE AT CHARENTON, LOUISIANA.

The project for expenditure of the appropriation under act of Congress approved March 3, 1881, of $25,000, was submitted to the Engineer Department by Major Howell, under date of April 30, 1881, and approved under date of May 20, 1881.

As the plan proposed for the improvement consisted of the construction of a canal, and as the land through which this canal is to be cut belonged to private parties, it became necessary to acquire the right of way before any steps could be taken for commencement of operations.

The deed having been accepted by the authorities at Washington, it was returned to me and received April 24. On this date a copy of the deed was sent to Mr. Acklen for registration, with request to return it at his earliest convenience. I also stated in that letter that when jurisdiction was ceded by the legislature of Louisiana the title would be considered sufficient. In reply Mr. Acklen, on May 20, 1882, informed me that in order to properly complete the title it was necessary to comply with article 46 of the State constitution, which provides that in such cases notice of thirty days must be given by publication before any action could be taken. Under date of May 22, 1882, I received a letter from Mr. Ed. Sillon, signing himself president of Charenton Canal, inclosing an extract from the official journal of Saint Mary's Parish, giving the requisite notice mentioned by Mr. Acklen.

The legislature of Louisiana took action in the matter, ceding jurisdiction to the United States in a joint resolution approved July 5, 1882, and an act approved July 6, 1882.

Title and jurisdiction being now settled, surveys for the exact location of the canal will be made as soon as possible.

The original amount estimated for this work was $75,000, of which $25,000 have been appropriated.

The balance of $50,000 I recommend be appropriated for the fiscal year ending June 30, 1884.

Total amount appropriated	$25,000 00
Total amount expended	774 00

Money statement.

July 1, 1881, amount available	$25,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	774 00
July 1, 1882, amount available	24,226 00
Amount (estimated) required for completion of existing project	50,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	50,000 00

M 11.

IMPROVEMENT OF BAYOU BLACK, IN LOUISIANA.

The examination of this bayou was provided for in the river and harbor act approved June 14, 1880, a report of which, together with the plan and estimate of cost of improvement, was published in Report of Chief of Engineers for 1881 (Appendix M 11).

By act of Congress approved March 3, 1881, an appropriation of $10,000 was made for commencement.

This work is of such a character that letting it out at contract was not deemed advisable, and as it was not practicable to hire a suitable dredge-boat, authority was obtained for building a hull, using the machinery of a clam-shell dredge at Galveston, which was transferred to this department by Maj. S. M. Mansfield, Corps of Engineers, upon the receipt of authority for so doing from the Chief of Engineers, the cost of hull, &c., to be charged equally to the appropriations for Bayous Terrebonne and Black. (See report of improvement of Bayou Terrebonne, this year.)

As soon as the appropriation for the Terrebonne is exhausted, it is proposed to transfer the dredge to the Black.

By act of Congress passed August 2, 1882, an additional appropriation of $10,000 was made for continuing the work. The original estimate for this work was $47,520, and it is recommended that the balance of $27,520 be appropriated for the fiscal year ending June 30, 1884.

The commercial importance of the bayou was stated in the report of examination.

The work is located in the collection district of New Orleans. The nearest light-house is at the entrance of Atchafalaya Bay.

Original estimate	$47,520 00
Total amount appropriated	20,000 00
Total amount expended	4,959 16

Money statement.

July 1, 1881, amount available	$10,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	4,959 16
July 1, 1882, amount available	5,040 84
Amount appropriated by act passed August 2, 1882	10,000 00
Amount available for fiscal year ending June 30, 1883	15,040 84
Amount (estimated) required for completion of existing project	27,520 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	27,500 00

M 12.

IMPROVEMENT OF BAYOU COURTABLEAU, LOUISIANA.

This work originated in an examination authorized by act of Congress approved March 3, 1879, a report of which, together with plan and estimate for improvement, was published in Report of Chief of Engineers for 1880 (Appendix M).

By act of Congress approved June 14, 1880, an appropriation of $7,500 was made for its commencement, and an additional appropriation of $7,500 was made for its continuance by act of Congress approved March 3, 1881.

In the report on this work for 1880 by Major Howell, my predecessor (see Report of Chief of Engineers for that year), it was recommended that in order to carry out the proposed plan of improving Little Devil Bar, near the Atchafalaya, which constitutes the principal obstruction to navigation between the two streams, a detailed survey be made to locate the sites of the dams required to close the bayous that leave the Courtableau on the south bank. By closing these bayous it was intended to concentrate the entire discharge of the Courtableau on Little Devil Bar, and thus cut it out. This recommendation was approved by the Chief of Engineers, and the report of Assistant Engineer Collins, who made the survey, will be found in the Report of the Chief of Engineers for 1881 (Appendix M 12), together with the project, in accordance with the facts as developed by the survey.

As it was practically impossible to frame specifications for letting this work out by contract, permission was asked and received to do it by hired labor and purchase in open market, and accordingly a party was sent from here, August 24, 1881, to commence the work, having as superintendent the assistant engineer who made the survey. Owing to Little Devil Bar being dry, it was not until September 16 that the quarter-boat got across it and actual work began. By March 19 the banks of the bayou were all under water, owing to the rapid rise in the Mississippi and Atchafalaya, and work was necessarily suspended. During the low-water season considerable delay was caused by sickness, at one time one-half the force being disabled with swamp fever.

During the season Bayou Big Fordoche was closed by a dam. This is the largest of the run-out bayous. The dam was carried up to 14½ feet above low-water. Its length across the bayou at bottom was 78 feet; at top, 130 feet. The width of the dam at bottom, up and down stream, was 120 feet; at top, 65 feet. The dam was composed of timber and brush strongly tied together, with a puddling of clay rammed in. The top of the dam is 3 feet below the level of the bottom land, the sudden rise of the water preventing its being carried higher.

All run-out bayous were choked by cutting the trees which grew on their banks, allowing them to fall into the bayous, which had the effect of reducing the current through them to less than 1 foot per second. In the large bayous this choking process was carried on throughout a distance of 3 or 4 miles; in the smaller ones not so far.

All overhanging trees along both banks of the Courtableau were cut down and floated into the run-out bayous from the Teche to the Atchafalaya, a distance of 18 miles, and the overhanging willows were also cut down for a distance of 6½ miles above the Teche. In addition all snags were removed for a distance of 12 miles down stream from the Teche. At present the water is still over both banks. It is impossible to tell at present what the change on Little Devil Bar, if any, may be. When the water has fallen sufficiently, it is proposed to close the remaining large bayous by dams, and continue the work of removing snags. It is thought that Bayou Jurommon, mentioned in the report of my predecessor, Major Howell, for 1881, as one of the five large bayous that would require closure by dams, may need no further attention, as upon examination it was found to be nearly closed by raft at some distance from its head.

The question with regard to a lock to carry low-water navigation to Washington will have to await the result of closing the run-out bayous and the effect on Little Devil Bar.

The removal of this bar will produce a lowering of the present low-water surface in the bayou, and until the amount of this is known there will exist no data for determining the lift of the lock.

The original estimate for this work was $40,000, of which $15,000 have been appropriated. It is, therefore, recommended that the balance, $25,000, be appropriated for fiscal year ending June 30, 1884.

The work is considered to be permanent in the ordinary acceptation of the term as applied to works of this kind. Its commercial importance was indicated in the report of the first examination.

The work is located in the collection district of New Orleans. The nearest light-house is at the entrance to Atchafalaya Bay.

Total amount appropriated	$15,000 00
Total amount expended	8,914 85

Money statement.

July 1, 1881, amount available		$13,781 39
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$7,387 24	
July 1, 1882, outstanding liabilities	309 00	
		7,696 24
July 1, 1882, amount available		6,085 15
Amount (estimated) required for completion of existing project		25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.		25,000 00

M 13.

IMPROVEMENT OF BAYOU TERREBONNE, LOUISIANA.

This work originated in an examination authorized by act of Congress approved March 3, 1879, a report of which, together with plan for improvement and estimate of cost of same, was published in Report of Chief of Engineers for 1880 (Appendix M).

By act of Congress approved June 14, 1880, an appropriation of $10,000 was made for its commencement. A project for application of this amount was submitted to the Chief of Engineers, and, having been approved by him, the work was duly advertised, and bids received and opened August 30, 1880. Only one bid was received, and that was rejected as being too high. Eventually a dredge-boat of the Osgood pattern was rented of the South Louisiana Canal and Navigation Company, and begun work December 23, 1880, at a point 23½ miles below Houma.

At the end of the fiscal year the dredge had reached a point 16 miles from Houma, having cleared out 7½ miles of the bayou. (See Report of the Chief of Engineers, 1881, Appendix M 13.) The boat was old and the work severe, and signs of weakness, especially about the derrick, began to develop themselves. On September 1 it was not considered safe to retain the dredge longer, for fear of her breaking down completely, and as the terms on which she was hired required that she be returned in as good condition as when first taken, the work was stopped and the boat returned to her owners. At this time she had reached a point 15 miles from Houma. Since then no work on the bayou has been done.

In consequence of the difficulty encountered in obtaining a suitable dredge-boat for continuing the work, under date of September 17, 1881, authority was requested from the Chief of Engineers to have the machinery of the clam-shell dredge at Galveston, for which Maj. S. M. Mansfield was responsible, transferred to this district, and also to construct a hull for same, the expense to be charged equally to the appropriation for Bayous Terrebonne and Black. This application was approved under date of September 28, and after advertisement by posters for ten days, bids for constructing the hull were received and opened November 9, 1881.

The following is an abstract of the bids received:

Numbers of proposals.	Names of bidders.	Price.	Remarks.
1.	J. H. Lynch	$6,600	Proposal does not provide for putting in the machinery.
2.	Henry A. Peeler	5,649	Proposal does not provide for putting in the machinery.

The bid of Henry A. Peeler was accepted, and under date of January 21, 1882, articles of agreement were entered into with him. The following is the body of the agreement:

This agreement witnesseth, that, in conformity with the advertisement and specifications hereunto attached, and which form a part of this contract, the said Amos Stickney, major of engineers, for and in behalf of the United States of America, and said Henry A. Peeler, for himself, his heirs, executors, and administrators, have mutually agreed, and by these presents do mutually covenant and agree, to and with each other as follows, viz:

That the said party of the second part shall furnish the material and construct a dredge hull with the accompanying house, derrick, booms, &c., attaching and fastening all castings, irons, &c., as per plans and specifications furnished by the party of the first part, and deliver the same to the party of the first part in the river at the city of New Orleans, La. It is distinctly understood that the United States is to furnish nothing except the plans and specifications.

That the said party of the first part, in consideration of the faithful performance of this specified work by the said party of the second part, agrees to pay to the latter the sum of $5,649.

By the terms of the contract the hull was to be completed March 31, 1882, but owing to certain causes of delay the time for completion was, under date of April 4, extended to May 1, and again, under date of May 3, to June 1. The hull was completed and paid for May 20, 1882.

PROBABLE OPERATIONS FOR 1882.

The dredge, when fitted out, will be sent to continue the work of the previous year, working towards Houma from a point about 15 miles below that place. When the appropriation is exhausted she will be sent to the Black. In all probability the navigation of the bayou will soon deteriorate after work is stopped, in consequence of material carried into it by the numerous drainage ditches of which each plantation has one or more. In nearly every case there exists at present, a little below the outlet of each ditch, a broad, flat bar, which will be reformed as soon as the dredge has passed. On this account the work cannot be regarded as permanent, unless some change is made in the method of draining.

Should steamboats be used on the bayou, they would undoubtedly serve to keep the channel clear much longer than can be expected from the passage of boats as now cordelled by mules. In the Report of Chief of Engineers for 1881 (Appendix M 13) it was estimated that $15,000 would be required to complete the work to Houma. Since then there has been expended in construction of dredge-boat $9,971.70, of which $5,262.70 is charged against the appropriation for Bayou Terrebonne, so that the estimate given above should be increased by $5,000, making $20,000; of this, $7,000 were appropriated by act of Congress passed August 2, 1882, and it is recommended that the balance, $13,000, be appropriated for the fiscal year ending June 30, 1884.

The work is located in the collection district of New Orleans. The nearest lighthouse is near the eastern end of Timbalier Island.

Total amount appropriated		$25,800 00
Total amount expended		17,222 81

Money statement.

July 1, 1881, amount available		$9,757 86
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$8,170 17	
July 1, 1882, outstanding liabilities	10 50	
		8,180 67
July 1, 1882, amount available		1,577 19
Amount appropriated by act passed August 2, 1882		7,000 00
Amount available for fiscal year ending June 30, 1883		8,577 19
Amount (estimated) required for completion of existing project		13,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		13,000 00

M 14.

IMPROVEMENT OF BAYOU LA FOURCHE, LOUISIANA.

This work originated from surveys authorized by act of Congress approved March 3, 1873, for reports of which see Reports of Chief of Engineers for 1874 (Appendix R 13) and 1875 (Appendix S 5).

Under act of Congress approved June 18, 1878, appropriating $10,000, a portion of the work was commenced. (See Report of Chief of Engineers for 1879, Appendix K 3.)

By act of Congress approved March 3, 1879, a further appropriation of $10,000 was made available, and with a portion of this and a balance of the preceding appropriation work was continued during fiscal year ending June 30, 1880.

By act of Congress approved June 14, 1880, an additional appropriation of $5,000 was made for continuing the work.

The original plan of improvement was to clear the bayou of the logs, stumps, and snags that interfered with navigation; and in carrying out this plan the work at the end of the last fiscal year had reached a point 8 miles below Lockport. (See Report of Chief of Engineers for 1881, Appendix M 14.)

The high-water of 1881 prevented resumption of work until August 6.

Work was suspended December 28, 1881, by the recurrence of high-water, at which time 9 miles of the bayou had been cleared, carrying the work to a point 17 miles below Lockport, with some work done below that point; 1,283 obstructions of various kinds were removed. At the end of the season the flat was cordelled up the bayou to Lockport and laid up in charge of a watchman.

Under date of March 29, 1881, I forwarded to the Chief of Engineers the following communication, which was printed in Senate Ex. Doc. No. 151, Forty-seventh Congress, first session:

UNITED STATES ENGINEER OFFICE,
New Orleans, La., March 29, 1882.

GENERAL: I have the honor to submit the following information in reply to department letter of 7th instant, transmitting Senate resolution of 2d instant, which directs the Secretary of War to transmit to the Senate an estimate of the expense of clearing the wrecks and other obstructions to navigation at the mouth of Bayou La Fourche, Louisiana.

There has been no survey or examination other than a simple inspection of the lower part of this bayou since 1874. At that time the lower part of the bayou was very much obstructed by tow-head islands, which were small islands of drift, snags, &c., with willow trees growing on them. Information given by inhabitants and from an inspection last summer shows that there has been a large accumulation of drift, snags, &c., near the mouth since 1874, and the tow-heads have grown larger. These tow-heads prevent a free discharge of the water.

It is not practicable to make an examination of the bayou at this time on account of the high stage of water. The work that has been done on the bayou, and which consisted of the removal of stumps, snags, drift, wrecks, &c., commenced at the head, and has reached a point about 20 miles below Lockport.

The work has not been completed to this point, for when the water rose some of the obstructions were necessarily passed and will require attention when the stage of water will permit. There remains of the amount appropriated for this work the sum of $4,865. Major Howell, in his annual report for year ending June 30, 1881, stated that the balance then on hand was deemed sufficient to complete the work of improvement under the project. The project under which the work was then being carried on was simply to continue the work of removing obstructions down to a point about 24 miles below Lockport.

From the above it would seem that Major Howell did not contemplate removing obstructions or doing other work below a point about 24 miles below Lockport, and therefore recommended no additional appropriation.

A continuation of the same kind of work down to the mouth would undoubtedly cause a somewhat freer discharge of flood-water, and while benefiting navigation would also give relief to a certain extent from the floods.

An additional appropriation of $15,000 would probably complete this work as thoroughly as practicable under the present method.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

The work, so far as the removal of obstructions is concerned, may be considered as susceptible of permanent completion.

As stated in my letter to the department of March 29, to continue the work to the mouth of the bayou an additional appropriation of $15,000 will be necessary, and it is recommended that that amount be appropriated for fiscal year ending June 30, 1884.

As soon as the water in the bayou reaches a proper stage work will be resumed, being carried on as heretofore by hire of labor and purchase in open market.

The work is located in the collection district of New Orleans. The nearest light-houses are at the mouth of the Mississippi River and at the entrance to Atchafalaya Bay.

Original estimate cost	$100,000 00
Total amount appropriated	25,000 00
Total amount expended	20,336 08

Money statement.

July 1, 1881, amount available	$8,776 77
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	4,112 85
July 1, 1882, amount available	4,663 92
Amount (estimated) required for completion of existing project	15,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	15,000 00

M 15.

IMPROVEMENT OF CALCASIEU RIVER, LOUISIANA.

This work originated in an examination authorized by act of Congress approved June 14, 1880, a report of which, together with plan and estimate of cost of improvement, was published in Report of Chief of Engineers for 1881 (Appendix M 15.)

By act of Congress approved March 3, 1881, an appropriation of $3,000 was made for commencement of work. The project for application of this amount having been submitted to the Chief of Engineers, and by him approved, the work was duly advertised, and the only bid received opened July 30, 1881. As this bid was conditioned by the bidder on his being awarded the contract at Calcasieu Pass, for which he was not the lowest bidder, and as the amount appropriated ($3,000) was not deemed sufficient to warrant the construction of plant and commencement of work by hired labor and purchase in open market, it was recommended that the work await further appropriation. The bid of Mr. Maguire was therefore rejected by the Chief of Engineers and further action postponed.

By act of Congress, passed August 2, 1882, an additional appropriation of $7,000 was made. The original plan contemplated the improvement of the river from Phillips' Bluff to Lake Charles, a distance of 56 miles, the estimate for which was $10,080.

The survey of this river upon which this estimate was based was, from some misapprehension on the part of the officer in charge, only carried from Phillips' Bluff to Lake Charles.

Before beginning any work I think it would be advisable to examine the lower part of the river; until that is done I can make no recommendation with regard to additional appropriation.

The commercial importance of the work was indicated in report of examination.

The work is located in the collection district of Galveston, Tex. The nearest light-house is at the entrance to Calcasieu Pass.

Original estimate	$10,080 00
Total amount appropriated	10,000 00
Total amount expended	8 61

Money statement.

July 1, 1881, amount available	$3,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	8 61
July 1, 1882, amount available	2,991 39
Amount appropriated by act passed August 2, 1882	7,000 00
Amount available for fiscal year ending June 30, 1883	9,991 39

M 16.

IMPROVEMENT OF CALCASIEU PASS, LOUISIANA.

An examination of this pass was made in 1871, and a project for its improvement, together with estimate of cost of same, published in Report of Chief of Engineers for 1871 (Appendix N 12).

By act approved June 10, 1872, an appropriation of $15,000 was made for this work; and under date of June 24, 1872, a project for its application was submitted to the Chief of Engineers, which comprised dredging a channel 80 feet wide and 5 feet deep at mean low-tide across the bar at the foot of Calcasieu Lake, the dredged material to be deposited on side of cut.

The work to be done by hired labor and purchase in open market, using the government dredge-boat then at work on Red Fish Bar, Galveston Bay.

The cut was completed January 14, 1874, and at that time was 60 feet wide, 6½ feet deep, and 6,300 feet long.

The cut gradually filled up with material carried into it by cross currents and winds; besides, as no tow-boats were used in taking vessels through, these latter were constantly getting out of the channel, and being hauled back into it, also carried into the cut a large amount of material.

By act of Congress approved March 3, 1881, an appropriation of $12,000 was made for reopening the cut. A project for application of this amount was submitted to the Chief of Engineers, and upon its approval advertisements inviting proposals were duly published and bids opened July 30, 1881. The following is an abstract of those received:

Abstract of proposals received in response to the attached advertisement dated June 30, 1881, *and opened July* 30, 1881, *by C. W. Howell, Major of Engineers, U. S. A., for improving Calcasieu Pass, Louisiana, dredging.*

Number of proposals.	Names of bidders.	For extension of cut, dredged as specified.	Quality, &c., of plant to be used in dredging.
1	John Maguire	3,750 feet long, 70 feet wide, 8 feet deep, or 7,500 feet long and 35 feet wide, 8 feet deep, $10,800.	Necessary outfit.
2	James E. Slaughter	7,500 feet long, 8 feet deep, 50 feet wide, $10,800.	One dredge.
3	William Fagan	7,500 feet long, 8 feet deep, and 70 feet wide, $10,500.	A menge dredge, full working crew, and all necessary appliances.
4	George C. Fobes & Co	7,500 feet long, 8 feet deep, and 70 feet wide, $10,444.	One clam-shell dredge.

The bid of George C. Fobes & Co. being the lowest responsible one, the contract was awarded them, and articles of agreement entered into under date of September 17, 1881, and approved by the Chief of Engineers under date of October 25, 1881.

The following is the body of the agreement:

This agreement witnesseth that in conformity with the advertisement and specifications hereunto attached, and which form a part of this contract, the said Charles W. Howell for and in behalf of the United States of America, and the said George C. Fobes & Co., for themselves, their heirs, executors, and administrators, have mutually agreed, and by these presents do mutually covenant and agree to and with each other as follows, viz:

To perform the work of dredging a channel through the lower end of Calcasieu Lake, Louisiana, 7,500 feet long, 70 feet wide at bottom, and 8 feet deep at mean low-tide. Material dredged to be deposited on either side of cut as may be found most convenient.

The location of channel will be staked out, and the plane of mean low-water established by the United States.

For and in consideration of the said parties of the second part faithfully complying with their agreement, the said party of the first part agrees to pay to the said parties of the second part, their heirs, executors, or administrators, the sum of $10,444.

The contractor having reported that the work would be completed early in February, 1882, an inspector was sent to examine it on the 5th of that month, and under date of February 16 reported that the work had been completed in accordance with terms of contract. Cross-sections of the cut were sounded 100 feet apart.

It is not expected that this new channel will remain open for any considerable length of time.

The commerce of the locality has increased very much since the first examination of the bar was made, and the schooners which run in this trade still find their way in and out through the cut, without the assistance of tow boats. It is probable that to preserve a constant channel here, dikes of light construction will have to be made to prevent material from being washed into it, and also to keep boats passing through, in the cut.

At present, however, the commerce of the locality would hardly justify the expenditure of the amount necessary to do this.

By act of Congress passed August 2, 1882, an additional appropriation of $3,000 was made for this work. This amount might remain until it becomes necessary to again reopen the cut. I do not recommend any appropriation for next fiscal year.

The work is located in the collection district of Galveston. The nearest light-house is at the Gulf entrance of the pass.

Original estimate	$15,000 00
Total amount appropriated	15,000 00
Total amount expended	11,843 25

Money statement.

July 1, 1881, amount available	$12,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	11,843 25
July 1, 1882, amount available	156 75
Amount appropriated by act passed August 2, 1882	3,000 00
Amount available for fiscal year ending June 30, 1883	3,156 75

M 17.

REMOVAL OF WRECK IN PASS MARIANNE, MISSISSIPPI SOUND.

This obstruction to navigation of the pass was caused by the wreck of a bark lying across the channel, leaving only a narrow passage-way on either side for vessels going in or out. Several masters of vessels having notified the honorable Secretary of the Treasury that the presence of this obstruction was dangerous to navigation, the matter was referred to the honorable Secretary of War for his information, and by him to the Chief of Engineers, who directed me to obtain such information as was available without making an examination of the locality. Under date of February 1, 1882, I reported to the Chief of Engineers such facts as I had been able to obtain, and upon the receipt of the following letter of instructions at once began preparations for the removal of the wreck:

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 15, 1882.

SIR: The Secretary of War has approved the recommendation of the Chief of Engineers that the necessary steps for the removal of the wreck in Pass Marianne, Mississippi Sound (upon which your report of the 1st instant was made), be taken as provided for in section 4 of the river and harbor act of June 14, 1880.

You will accordingly proceed without delay with the necessary measures for the removal of the wreck in question, giving the required notice to parties interested to remove the same, &c., and upon their failing to do so to invite proposals for its removal by contract in the usual way.

By command of Brigadier-General Wright.

Very respectfully, your obedient servant,

JOHN G. PARKE,
Lieutenant-colonel of Engineers,
Bvt. Maj. Gen., U. S. A.

Maj. AMOS STICKNEY,
Corps of Engineers.

In compliance with requirements of section 4, river and harbor act of June 14, 1880, public notice was duly given calling upon persons interested to remove the wreck, otherwise the property would be considered as abandoned and derelict, and the United States would proceed to remove the same. This notice meeting with no response, advertisements dated April 17, 1882, were duly published inviting proposals for removal of wreck.

The following is an abstract of the bids received and opened May 19, 1882:

Abstract of proposals for removal of sunken vessel in Pass Marianne, Mississippi Sound, received in response to the attached advertisement dated April 17, 1882, and opened May 19, 1882, by Amos Stickney, major of engineers.

Number of proposals.	Names of bidders.	Date of commencing operations.	Date of completion of work.	Price.
1	Frank Beck, jr., and James L. Burriss.	Within fifteen days from acceptance of bid.	Thirty days ..	$3,800
2	J. H. Lynch and T. F. Colburn....	June 1, 1882..........................	Two months..	3,950

The bid of Messrs. Beck and Burriss being the lowest the contract was awarded them, and articles of agreement entered into, under date of June 1, 1882, and approved by the Chief of Engineers under date of June 7, 1882. The following is the body of agreement:

That the said party of the second part will completely remove the wreck of sunken vessel and cargo now lying in Pass Marianne, Mississippi Sound, taking out all parts of the wreck and cargo, and landing same above high-water at some convenient point, as provided for in said specifications.

Portions of wreck or cargo possessing value will be landed at such point as may be directed by the said party of the first part.

The said party of the second part also agrees to furnish all facilities to the inspector, to be appointed by the said party of the first part, to enable said inspector to visit and inspect the said work during its progress and after its completion.

That the said party of the first part, in consideration of the faithful performance of this specified work by the said party of the second part, agrees to pay to the latter the sum of $3,800.

The contractors at once began operations and the work was completed, and settlement effected July 6, 1882.

An inspector was present while the work of removal was going on.

The work is located in the collection district of New Orleans. The nearest lighthouse is Pass Marianne light.

Total amount appropriated	indefinite.
Total amount expended..	$90 62

M 18.

SURVEY FOR A BREAKWATER IN LAKE PONTCHARTRAIN, IN THE VICINITY OF NEW CANAL OUTLET, NEAR NEW ORLEANS, TO SERVE AS A HARBOR OF REFUGE.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 13, 1882.

GENERAL: I have the honor to make the following report on the "survey and estimate for a breakwater to be constructed from a point at or near the New Canal outlet, near New Orleans, La., to the Pontchartrain Railroad wharf, said breakwater to be so constructed as to serve as a harbor of refuge for all vessels," called for in the river and harbor act of March 3, 1879.

The survey was made by Assistant Engineer H. C. Collins in the summer of 1880, but owing to the illness of Major Howell the subject seems to have remained unconsidered.

In view of the fact that the southern shore of Lake Pontchartrain has no harbors except the mouths of the canals, into which vessels can run for refuge, I consider the construction of a breakwater a matter of very considerable importance. I do not see the necessity at present for the construction of such a long line of breakwater as seems contemplated in the act directing the survey, viz, "from a point at or near the New Canal outlet, near New Orleans, La., to the Pontchartrain Railroad wharf," which is a distance of a little over 3 miles, unless the main object is to protect a narrow strip of land along the lake. If this is the object it can be effected far more economically by a revetment, which, placed on the face of a low levee, would also protect the city of New Orleans from overflows caused by the piling up of the water in the lake during strong east winds. I would recommend the construction of a breakwater in two sections, each about 4,000 feet long, placed in front of the entrances of the two canals and on a line parallel to the shore, and about 4,500 feet from it, as shown on the accompanying chart. This would be about 2,000 feet in front of the New Canal entrance and 1,500 feet in front of Bayou Saint John entrance, and in a depth of water varying from 11½ to 12½ feet. As 8 feet is the maximum draught of vessels navigating the lake, this position of breakwater, while covering the entrances, would give ample anchorage area for present needs, and would admit of very considerable enlargement for future wants by simply connecting the detached sections and continuing the line to the eastward. The plan of breakwater that I would recommend would be a modification of those constructed on the northern lakes, viz, timber cribs, with partly open bottoms, resting on piles and weighted with such material as could be most economically obtained in this region. Stone might possibly be had within a reasonable cost from a point about 125 miles up Pearl River; that failing, shell concrete and broken brick could be used. I think a breakwater of this description with a width of 12 feet would cost about $35 per linear foot, which for 8,000 feet would be $280,000.

To construct a continuous breakwater of similar character from the New Canal to the Pontchartrain Railroad wharf would cost—16,500 feet, at $35, $577,500—more than double the first amount. The plan of breakwater adopted in 1853, and upon which 1,500 feet was constructed, proved to be inefficient, the upper part of the structure being destroyed in a comparatively short time. Its position, so far out in the lake, required a considerably longer line than the one which I recommend, and contemplated the protection of a much larger anchorage area than present needs would seem to require.

I transmit herewith Mr. Collins's report on his survey, together with a tracing of the chart; also tracing showing old plan of breakwater referred to in Mr. Collins's report; also a table showing the commerce to be benefited.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. H. C. COLLINS, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *June* 10, 1882.

SIR: Acting under instructions from Maj. C. W. Howell, United States Engineers, I made a survey of the Lake Pontchartrain front of New Orleans, from the New Canal to the Pontchartrain Railroad wharf, in April, May, and June, 1880.

Soundings cover the whole lake front to a width of nearly a mile from above the old Carrollton Railroad wharf to below the Lake Pontchartrain Railroad wharf; and twelve lines of soundings were made out to the 14-foot curve at mean low-tide, which was from 2 to 3 miles off shore. Tide-gauges were placed at the New Canal and at Bayou Saint John and connected by level line with the city engineer's bench-marks.

Mean low-tide, to which all soundings are reduced, is 25 feet below the city datum plane, and 5 feet below the top of Metairie Ridge.

Extreme low-tide, which is due to northwesterly gales, is said to be nearly a foot and a half below this mean low-tide. These gales only occur in winter, and it is only when they last three days or more that their full effect is seen in blowing the water out of Lake Pontchartrain, lowering the water surface along the north shore of the Gulf as far east as Mobile.

Three drainage canals from the city enter the lake within the limits of the survey, and one just east of the east line. The two navigable canals are called New Canal, which was dug by the city of New Orleans, and Bayou Saint John, which was a navigable bayou at the first settlement of New Orleans, but has been deepened in some places and extended to a basin in the city; and its entrance into the lake has been deepened and a jetty made on each side out to about the 6-foot curve in the lake. Toll is charged on vessels entering Bayou Saint John by the company who claim ownership of the improvements on the bayou. Toll was charged on the New Canal, but it has been made a free channel by the city.

Soundings were made in both navigable channels up above the bridges. The water which flows from the drainage canals is very dark, at times black. There is a large amount of organic matter in this water, but there is so little deposit from it that there is no advance of any curves in front of either of the drainage canals, nor is there any indication on the bottom of any filling due to them.

Shell banks are found in long, narrow reefs, nearly parallel with the shore, but not farther out than about the 7-foot curve. There is usually about a foot less water on top of these shell reefs than there is just shoreward from them.

Sand bottom is found in many places where the depth is 10 feet or less.

Near the new canal a bucket dredge was digging up earth for an embankment, from a place where the lake bottom had evidently not been disturbed before, and the water was 3½ feet in depth. She was cutting to a depth of 11 feet. The material dredged up was dark mud, which, when dried, proved to be nearly all very fine sand, with some vegetable matter and a little clay, but it was not such as would resist any washing of waves. When thrown up and protected by a revetment it makes a good levee. Outside of the 10-foot curve the bottom is all blue, sticky mud, with broken shells, and living shell-fish were occasionally found. When dry, this mud was almost exactly like that dredged up near shore. In places a slight film of yellow mud was found on the bottom, which was evidently deposited from the Mississippi River water, then running into the west end of the lake from Bonnet Carre Crevasse. This was so thin as only to stain the lead slightly at times, and some of it came up on the anchors to the buoys. This yellow mud is so thin that whenever the water is very rough it is taken up and held in suspension, making the water yellow when a gale had blown for a few days.

The bars which obstruct navigation at both canals are of sand, and there was but 5 feet depth at low-tide at either canal over the bar. The sand appears to drift into the entrance of the canals during gales, and then to be thrown out onto the bar, by the current at ebb-tide, out of the canals. The entrance to the New Canal is protected by a jetty on each side, made of material dredged from the canal, and kept in place by crib-work or piling, with a revetment of plank outside to protect it from the lake waves. The shore line is washing away except where protected for the whole front surveyed.

Old cypress stumps remain, forming a belt from 200 to 500 feet in width outside the present shore line. The trees were cut so long ago that the cypress knees which formerly protected the land from action of the waves have disappeared. A good road was made from the New Canal to Lake Pontchartrain wharf at Milneburg, and was in use in part as lately as 1870, but it now is seen only on a few points which project far beyond the general shore line.

The city of New Orleans made a breakwater in 1872. It was made in shoal water; about a foot deep just outside the line is its present depth, and earth for a levee was dredged from inside, and a sloping revetment of plank was first made to protect it from wash, but it soon broke down and was replaced by one made of round piles driven in a line and touching, leaving a space between the plank sheet piling and the round piles about 4 feet wide. The space was filled with brickbats and old ballast. The plan for it was made by General Weitzel.

The piling is 5 feet above low-water, and the top of the levee back of it is 2½ feet higher. This breakwater begins at the shore line at the west side of the upper drainage canal, runs out to the 1-foot curve, and then turns to eastward and runs to the west side of the New Canal. The original plan of this breakwater was for its continuation some miles along shore to a point below the Pontchartrain Railroad wharf. It would be, if made, only a shore protection, and not a "harbor of refuge" in any degree, except at cost of dredging the entire area to be used for harbor, and dredging and keeping open the entrance from the lake.

The shore to be protected is but a low swamp for some miles back to Metairie Ridge, covered with water most of the time. The only habitable portion is the ridge, a few feet wide at the lake shore, which is only occupied at the three little villages of Milneburg, Spanish Fort, and West End.

A breakwater to form a "harbor of refuge" and at the same time a safe harbor for the lake commerce of New Orleans should be made as far out as the 10-foot curve at least, and it is far more necessary now than it was at the time of the survey, as the railroad bridge across the lake will soon cut off the only shelter on the south side of the lake which has ever been available in a hard blow from northwest, that under the lee of Pointe-aux-Herbes.

An appropriation was made in 1852 for a "harbor of refuge," and it was begun in 1853–'54, and a section of 1,500 feet of it was finished in March, 1855. This section was in front of the Pontchartrain Railroad wharf, about on the 12-foot curve. The piles, four rows, on which this breakwater was made are yet standing to low-water line, and about one-quarter of them are standing to the top, but above water line, and partly rotted. Three rows of these piles supported a framework of square timber bolted on a slope, the outer edge of which was 2 feet under water, and the inner edge 5 feet above water; piles were 8 feet apart; these square timbers running across the line, and on their tops were bolted joists at intervals of a foot, to break the waves. These piles are now covered below water with barnacles, but there are no teredo in them. Taking the tops of the piles, as shown on the plan of the work, and as found now at the survey, the water surface is found to be the same in both surveys, that of 1853 and 1880, and the soundings of 1853 show the same depth in the same place as is now found, showing that in plans for harbor no allowance need be made for any filling of the lake.

Captain Williams was in charge of the Pontchartrain Railroad wharf during the building of this breakwater, and for many years after. He says that while the top was in place it acted as a good protection, but that by the fall of 1856, or during the winter of 1856–'57, the top was washed off, and since then it has been a bad obstruction in foggy weather, schooners having many times run into it to their great damage, and one schooner ran through it and was wrecked. The railroad wharf was not protected in the least except when the wind was NNE.; a point change either way would throw the swell on to the wharf. A breakwater like that of 1853 would cost, at the same rate as that between the New Canal and Pontchartrain Railroad wharf, $226,562.50, or for the distance from the New Canal to Bayou Saint John, $139,625. When its top went off the remaining piles would be only a greater obstruction to commerce than the present remains of that of 1853 now are.

Wood will last very many years below the low-water line. The piles driven in 1853 are now sound, and have, to all appearance, as firm hold in the bottom as when first driven. This would show that a work should be so made that the portion above water can be renewed, while that below low-water line would last for very many years.

Ballast can be had in any amount from the rock bluffs on Pearl River, as soon as the work on that stream is so far completed as to permit of its navigation by tugs and flat-boats. This would be better than concrete, but sand and shells for concrete, and brickbats from the brick yards, can be had in all the rivers on the north side of Lake Pontchartrain.

A "harbor of refuge" would be large enough for all needs, and, also, would be ample for purposes of commerce, if it extended only from the New Canal to Bayou Saint John.

The commerce of the lake is now mostly schooners, in wood, charcoal, lumber, and brick trade, and a few steamers which carry passengers to the watering places on the north side of the lake; but for some years efforts have been made to connect the lake with the Mississippi River by a canal. A survey for a canal to connect them by way of Bayou Manchac was made last fall; and one for a canal through the rear of the city of New Orleans, which will answer the same purpose, of connecting the river and lake, is now talked of and is likely to be made the coming summer. This would bring a lighter class of boats into lake navigation, and would make yet more necessary a safe harbor for them on this side of the lake.

Very respectfully, your obedient servant,

H. C. COLLINS.

Maj. AMOS STICKNEY,
United States Engineers.

Commerce of Lake Pontchartrain for the year 1881, *passing into New Orleans. No account was kept of vessels passing out.*

	New canal.	Bayou St. John.	Total.
Number of vessels entering	3,385	3,180	6,565
Tonnage of vessels entering	89,491	Not given	89,491
Bales cotton	8,642	52	8,694
Lumber, board measure	57,434,000	13,647,000	71,081,000
Timber and logs, board measure	9,189,840		9,189,840
Fire wood ... cords	21,270	24,787	46,057
Shingles ... M	10,870	2,302	13,172
Laths ... M	1,761		1,761
Charcoal ... barrels	334,500	394,600	729,100
Tar ... do	2,673		2,673
Brick ... M	2,510	702	3,212
Shells ... barrels	38,500	2,850	41,350
Sand ... do	170,900	70,670	241,570
Turpentine ... do	3,690		3,690
Rosin ... do	26,020		26,020
Live cattle	1,650		1,650
Hides	18,690		18,690
Sugar ... tons	456	179	635
Molasses ... barrels		300	300
Rice ... do	1,500		1,500
Moss ... bales	1,090	46	1,136
Oysters ... barrels		71,450	71,450
Cotton seed ... bags	293		293
Potatoes ... barrels		500	500
Sundries ... packages	10,580		10,580
Staves ... M		1,837,000	1,837,000

M 19.

SURVEY OF ATCHAFALAYA RIVER, LOUISIANA, FROM BERWICK'S BAY TO MOUTH OF RED RIVER.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., April 26, 1882.

GENERAL: I have the honor to submit the following report on the Atchafalaya River, compiled from the notes of Assistant Engineers Collins and Hoffman, who made the survey called for in river and harbor act of June 14, 1880, of "Atchafalaya River, Louisiana, from Berwick's Bay to mouth of Red River." This report, together with report of Major Howell, October 5, 1874, which will be found in the Annual Report of the Chief of Engineers for fiscal year ending June 30, 1874, Part I, Appendix R 14, pages 771 to 776, will furnish the information called for in the resolution of the Senate of the United States of December 21, 1881, which was transmitted to me in department letter of December 28, 1881. This report has been delayed by absence in the field of one of the assistant engineers who made the survey. The project for the survey of the Atchafalaya River will be found in the following letter:

UNITED STATES ENGINEER OFFICE,
New Orleans, July 8, 1880.

GENERAL: I have the honor to submit the following project and estimate for a detailed survey and examination of Atchafalaya River (including Grand Lake), from Berwick's Bay to mouth of Red River, as provided for in section 2 of the river and harbor act approved June 14, 1880.

Grand Lake is included in this project, because it receives at its head the waters of the Atchafalaya through a number of bayous into which the river divides itself above, while from the foot of it the old Atchafalaya, joined 3½ miles from its head by Bayou Teche, leads into Berwick's Bay. The importance of the Atchafalaya as a high-water outlet of the Mississippi is deemed sufficient to warrant the expense of a detailed survey of it and of its principal branches leading into Grand Lake, also Grand River, to connect with Bayou Plaquemine.

The route followed by commerce on Grand Lake is along its eastern shore, and on this account it is proposed to include this shore of the lake in the detailed survey. It is also proposed to make a transit and stadia reconnaissance of the western shore of Grand Lake and of the smaller branch bayous of the river. Six large navigable bayous empty into Grand Lake on its eastern shore, connecting with the Atchafalaya above, and it is considered of importance that these should be examined.

ESTIMATE.

Detailed survey, 280 miles, at $30 per mile	$8,400
Examination, 500 miles, at $10 per mile	5,000
Hydrography (Grand Lake), 100 square miles, at $4 per mile	400
	13,800
Contingencies, 20 per cent	2,760
Total	16,560

The project and estimate include the locating of all obstructions to navigation and gaining all information needed to estimate for the removal of the same, and for showing the commercial importance of the river and its branches. An examination simply would cost $9,840.

Very respectfully, your obedient servant,

C. W. HOWELL,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

This project, Captain Lockwood informs me, was not strictly carried out, because Major Howell considered the first 3 miles from Red River was sufficiently covered by Major Benyaurd's surveys, and the portion below the head of Grand Lake presented no obstacles to navigation, and was sufficiently covered by the survey of 1874.

The survey was commenced in the latter part of September, 1880, at a point 3 miles from the head of the river, and was continued down stream to Butte la Rose, which point was reached November 22. From this point the line followed was via Ouska Bay and Grand River to the Plaquemine, thence up the Plaquemine to its head. After this, the work was carried down Lower Grand River from the mouth of the Plaquemine to the junction of the Grand and Bayou Sorrel, down the former to Dr. Choppin's sugar-house, and down the latter to Lake Chicot, when (February 5), the water having reached such a stage as to seriously interfere with the work, stations for future reference were established, and the quarter-boat taken back to the head of the Plaquemine.

In September, 1881, the survey was continued by Assistant Engineer Hoffman, who ran a line down the Little Tensas, Tensas Bay, Lake Mongoulois, and Bayou Chéne to Lake Chicot; another down the Big Tensas to Lake Mongoulois, then the line Little Atchafalaya and La Rompe to Lake Mongoulois. Bayous Rigarby, Jake, &c., to Lake Chicot, were then surveyed; and lastly, the connection between Lake Chicot and Grand Lake.

Throughout the survey the main lines were run on true azimuth, while compass bearings were taken in running out the small bayous. Distances were measured with a stadia. Where possible, precautions were taken to insure the permanency of instrumental stations, and for this purpose live trees were cut down and their stumps used; as most of these will sprout out and continue growing, there will doubtless be no trouble in future surveys in finding a sufficient number of points to connect with the present one.

A line of levels was run, connecting Major Benyaurd's benches, 3 miles from the head of the Atchafalaya, with tide-water in Lake Chicot, via the Atchafalaya, Grand River, Little Tensas Bayou, and Bayou Chéne. The line was also extended, via Grand River and Bayou Plaquemine, to the Mississippi at the town of Plaquemine. Bench-marks were established frequently, in most cases by driving a nail in a notch in a live tree, and, as these are plotted on the chart, they can be readily found in future when necessary. The reference of water surface was determined at several points in each mile. Gauge readings were taken at the head of the Atchafalaya throughout the survey, and also, from December 1, at La Rompe, a few miles below Butte la Rose. The plane of reference for all levels reads 0.00 on the gauge at head of Atchafalaya.

SOUNDINGS.

Cross-sections were taken in the obstructed portions of the river at intervals, varying from 100 to 250 feet; where there were no obstructions the distance between cross-sections was from 1,000 to 2,000 feet. Each cast of the lead was instrumentally located.

DETAILED DESCRIPTION.

Commencing at the upper limit of the survey, which was Major Benyaurd's lower cross-section line, the river banks are 43.5 feet above low-water.

Bayou De Glaize enters the Atchafalaya at Simmsport, and the west bank, between its mouth and Lower Old River, is covered with woods; below Simmsport the west bank is leveed, as is also the east bank, the levee on the latter side extending to Old River above.

One mile above Simmsport, on the east bank, a recent cave showed evidences of the old raft that formerly filled the river; above the old pieces of logs, &c., which showed to a height of 10 feet above the water surface at the time of the survey, or 20 above low-water of 1879, there was a deposit 23 feet in depth of red and gray clay and surface soil. In the raft material, pieces of red cedar were found, the inner portions of which were solid, but other woods had become so changed by age and the constant and heavy pressure they had been subjected to that it was impossible to tell to what species they belonged. The pressure had been so great and so long continued that many pieces were flattened and much compressed. On this bank no blue clay was observed above Simmsport. In taking cross-sections, log bottom was found in many places, which was evidently indication of raft formation like that exposed by caving of left bank before mentioned. The river was at one time filled up with rafted material, which was cleared out to a certain extent by the State of Louisiana before the war.

The cross-sectional area of the river at Simmsport was at the time of survey 19,667 square feet, but at the height of high-water of 1874 it would be 54,550 square feet. The gauge reading at the time the cross-sectional area was determined was 10,152 feet. The high-water gauge reading of 1874 was 44,509 feet; the low-water of 1879, 0.000 feet, and of 1880, + 5.00 feet.

Simmsport is the shipping point for the country up Bayou De Glaize as far as Evergreen. Both banks of the river here are caving, and three successive levees have been built on both sides of the river, and in some places the fourth levee is now at the top of the bank and in danger of going in. Mr. Barbre, who settled here in 1828, and several other old inhabitants, told Mr. Collins that formerly at low-water there used to be a good ford for stock at Simmsport; but now the river is 630 feet wide at low-water and about 50 feet deep, while during high-water of 1874 it was about 100 feet in depth. This is said by old inhabitants to be the same place where the ford was in 1840, and at that time a log was used by foot-passengers to walk across on, the ends of the log resting on either side of the river, which is said to have been but 40 feet in width.

On the right bank, just below Simmsport, a large cave exposes blue clay, the top of which has a reference of 29.19 feet. Above this blue clay is red soil of Red River deposit. Soundings near the channel give blue clay bottom. The right bank throughout the third mile is caving, and the left also at the lower end.

Fourth mile.—The left bank is caving all along this mile, and the right bank near the lower end of it. During the high-water of 1874, a crevasse was formed in the left bank near the lower end of this mile; the hole cut out was 35 feet deep, extreme width 350 feet; this has been closed.

Fifth mile.—The right bank is caving throughout this mile, but the left bank only at the lower end of it. Twenty-eight cross-sections were sounded in the first 5 miles, and the shoalest section shows 22 feet in channel at extreme low-water, while the least width at this stage was 500 feet. There were at the time of survey four snags in sight in the 5 miles mentioned, which projected above the water from 3 to 6 feet, the stage of water being about 10 feet.

Sixth mile.—The whole left bank and the right bank also in the lower half of the mile are caving.

Seventh mile.—The mouth of Yellow Bayou, which formerly entered the river from the west near the upper end of this mile, has been closed by a levee. The right bank of the river is caving throughout the mile, but nowhere was blue clay exposed. The depth of water in channel is nowhere less than 34 feet at extreme low-water.

Eighth mile.—The whole left bank and the upper and lower fourths of the right bank are caving. The mouth of Bayou Moreau, which formerly entered the river at about the middle of this mile, has been closed by a dam. The bayou originally discharged into the Atchafalaya only during low-water in the latter.

Ninth mile.—The right bank of the upper half and the left bank for the whole extent of this mile are caving.

Tenth mile.—Both banks throughout this mile are caving. Three bad snags were found in the 5 miles ending with the tenth. These are only dangerous when below the surface of the water, as when they are visible there is ample room to avoid them.

Eleventh mile.—The river here makes a sharp bend to east-southeast, and the right bank is caving fast. A depth of 80 feet is found in the bend at extreme low-water.

Twelfth mile.—The river here turns sharply to westward. The entire left bank and the upper right bank are caving fast. Three bayous, Marine, Middle, and Stark, which formerly entered from the east, have been closed.

Thirteenth mile.—Both banks are caving throughout this mile.

Fourteenth mile.—Near the lower end of this mile the rapid caving of the point in the sharp bend that formerly existed here has straightened the river, and the old bend is rapidly shoaling.

Fifteenth mile.—The entire left bank and nearly all the right bank in this mile are caving. On the east side no levees were visible, and the old cleared fields were partly grown up with trees and brush. The land on the west bank is still under cultivation.

In the 5 miles ending with the fifteenth eight large snags or drift trees were found. The shoalest cross-section showed 18.5 feet at extreme low-water, while in the bend on the fourteenth mile a corresponding depth of 91.5 feet was found. There are six bends of about 90° in this 5 miles.

Sixteenth mile.—The river here is nearly straight and both banks are caving.

Seventeenth mile.—Same as for sixteenth mile.

Eighteenth mile.—There is a sharp bend to the east near the head of this mile, and one to the south at its lower end. Both banks are caving, the land going in in large slides. The cross-section at lower end of the mile shows a depth of 120 feet at extreme low-water.

Nineteenth mile.—The course of the river throughout this mile is about south. Both banks are caving. On the west bank, near the lower end of the mile, is the old mouth of Bayou Current, which formerly emptied into the Atchafalaya during low-water. The head of a great block of raft was originally just below here, and during high-water the Atchafalaya discharged its waters into the west side swamps through the bayou. After the removal of the raft a high dam connecting with the levees was built across the mouth of the bayou. The land on the west side of the river is under cultivation, but the east side levees are too low to guard against high-water, and the plantations below the fifteenth mile have been abandoned. The stage of water when the survey reached this point was about 9 feet above extreme low, and the remains of the old raft formation showed above water at about the end of this mile, while the cross-section taken just above showed log bottom on each side of the channel.

Twentieth mile.—Except for the lower 1,200 feet of this mile the old raft projected above water at time of survey, and the logs of the sunken portion were so near the surface that the boils and eddies showed their position. A narrow channel through this section is comparatively clear, but the position of logs, &c., are constantly changing, as they are washed out and lodge lower down, so that steamboat navigation is dangerous at nearly all times. The bank is caving everywhere on both sides throughout this mile. The channel is getting better each year as the old drift logs are washed out, but the removal of the raft by a snagboat would be a much more expeditious method, and, considering the dangers to navigation, more economical as well. The rafted material extends under the banks on both sides, showing that the limits of the old channel have not yet been reached.

Mr. A. A. Richards states that when he settled in this locality (about 1840) the river was small, and that he could cross it anywhere on the raft for many miles; that it was hardly 200 feet between the high banks, and that there were no levees, and the land was never overflowed. At the time of survey the width between high banks was 800 feet, and the greatest depth at extreme low-water 35 feet. The banks of Lake Bayou, which enters the river from the east just below Mr. Richards' house, and the banks of the river itself cover old raft, the top of which is about 20 feet above low-water surface, and is covered by 15 to 18 feet of red deposit. The twentieth mile is nearly the head of the raft, which is almost continuous to Bayou Rouge.

Twenty-first mile.—Both banks are caving throughout this mile. Raft borders one or both sides in both places, and was found at the bottom with nearly every cast of the lead. The caving has been so rapid for the past year that the new levee, which was 220 feet from the bank, at Mr. Richards' house 1½ miles above, has caved in near the lower end of the mile. There is a ridge of logs near the middle of the river for most of this mile, which is said to have once projected above the water; its height is now 15 feet above the general bottom.

Twenty-second mile.—Both banks are caving throughout this mile. The old raft is found all along the left bank running under the red deposit. The section taken at the lower end of the mile shows a low-water width of 950 feet, and depth of 85 feet. The section 450 feet above has the same width, but a depth of 110 feet. The next, 400 feet further up stream, has a width of 380 feet and a depth of 29 feet.

Twenty-third mile.—Gordon's Island is on this mile. But a few years ago, according to the statement of Mr. Gordon, this island was quite extensive and heavily timbered; it was formed by a deposit of red soil on the old raft, and its elevation was about the same as that of the banks. Since 1874 the island has decreased materially in size, and the deposit of soil has been washed away so that nothing is left but the logs composing the raft and the mud that has settled between them. The upper end of the island is now below the zero of the level line, while the lower end is only 8 feet above that point. The river banks are caving everywhere on this mile. The depth of channel on the west side of the island is only 11 feet at zero of level line. The channel to the eastward of the island is only used with a 10-foot rise, and has not been used even at that stage but for a short time; it is now cutting out fast.

The land on the west bank is all under cultivation, the levees still being kept up, but on the east bank the levee is only found on projecting points, and the only crop raised is cotton that is planted after high-water.

The channel is improving each year as the raft is torn out by the current, and if this is increased, or even maintained as it now is, there will eventually result an unobstructed channel.

At present the convex as well as the concave sides of the bends are caving, and frequently whole points go in at one slide, shortening the channel. At the lower end of this mile and head of the

Twenty-fourth are large slides on each bank; here the depth of water is 42 feet, but just below the slides it is 108 feet at the zero of level line.

The increase in width of river due to these slides is 420 feet. Blocks of raft were found in the bed of the river by the lead in many places on this mile, while the banks are caving and sliding in more or less on both sides.

Twenty-fifth mile.—This mile reaches to Churchville. Log bottom is found everywhere throughout it. The cross-section of the river is fast increasing by caving of banks and scouring out of bottom.

Twentieth to twenty-fifth mile.—These 5 miles were one continuous block of raft when the State began the Atchafalaya improvement. For nearly all the distance the raft runs under one or both banks, and the bottom of the river is paved with logs, except where deep holes are found, showing that, great as has been the increase in the channel since Captain Bradley first cut the narrow passage through the raft, it is yet very far from being as extensive as it was before the rafting process originally began. Little cultivated land is now found on the east bank, although it was formerly leveed. On the west bank from two to five levees have been constructed, and the last one is now in danger of caving in at several places. All the land on this bank above the swamps is under cultivation, sugar and corn being the principal crops. The mouths of all bayous have been closed, so that drainage is now effected through the swamps. These bayous appear to have retained their original depths back of the dams, although their old mouths are nearly obliterated in every case. Before removal of the raft there was about equal cultivation on both banks, and no levees were needed; now there are only a few isolated places on the east bank cultivated.

Twenty-sixth mile.—Seventeen cross-sections were sounded on this mile, and in nearly all cases log bottom was found, and for about half the mile logs project above the water surface at extreme low-water.

The old mouth of Bayou Rouge is at about the middle of the mile on the west bank; it is closed by a high and wide dam connecting with the levees. In front of it are the remains of an old raft island, the logs of which show above the water surface with an 18-foot rise, for a length of about 1,000 feet, and width varying from 100 to 300 feet. Bayou Rouge is navigated by a small steamer, which transfers freight to the boats running regularly on the Atchafalaya. She supplies the plantations nearly to Evergreen. The channel by which boats pass the raft at the mouth of Bayou Rouge is one of the worst on the river, owing to the number of snags and the shoalness of the water at low-river. The bank is caving fast, and there is a strong current, even at low-water.

Twenty-seventh mile.—One of the great caves that is moving up and widening the river has reached about the middle of this mile, causing an abrupt increase in width of more than 200 feet on the right bank. The left bank opposite this cave has a block of old raft running under the bank, and all the cross-sections below it show log bottom and very shoal water along the left bank for one-third or one-half the width of the river. Both banks are caving for the entire mile.

Twenty-eighth mile.—The plantation of Dr. Hartman occupies the right bank on the twenty-eighth mile, and is the last one on which the levees have been kept up and rebuilt as they caved in.

Twenty-ninth mile.—The banks on this mile are caving rapidly. Cow Head and Muscle Bayous enter the river on the left bank, about 750 feet apart, near the middle of the mile. Between their mouths is the crossing of the New Orleans Pacific Railroad. The west side of the river at the railroad crossing is a point of land composed of hard clay, between two large caves, and projects into the river fully 200 feet beyond the general shore line above and below. The greatest depth at the crossing is 28 feet at zero of level line, and the width at low-water 600 feet. Fifteen hundred feet above this line a section shows a greatest depth of 95 feet, and 350 feet below there was found a depth of 56 feet at low-water.

Thirtieth mile.—The banks are caving fast on this mile and no effective levees remain. The old fields are covered with small trees. Four cross-sections were sounded on this mile, and the shoalest one gave a depth of 30 feet.

Thirty-first mile.—This mile includes two sharp bends, each of about 90 degrees. The upper one is called the steamboat graveyard, in consequence of three steamers having been snagged and sunk here. The projecting points on both banks are caving in fast, which has the effect of shortening the channel.

Thirty-second mile.—Both banks are caving. Five cross-sections were sounded on this mile, the shoalest of which showed over 40 feet of water.

Thirty-third mile.—Petite Prairie Bayou leaves the river on the right bank at about the middle of this mile, but at a 15-foot stage water also leaves the river for the same bayou through three washed-out channels at the upper end of the mile. This bayou previous to 1874 was choked with raft, but the high-water of that year cleared it out, and now its banks are caving fast and increasing its cross-section. It runs out into the swamps and river lakes.

Thirty-fourth mile.—This mile includes Wiltsey's Island, which is still covered with red soil to a height of 15 feet above the old raft, which forms the foundation of the island. This raft formation extends 2,300 feet above the high part of the island, portions of it still showing above water even with a 10-foot rise. The high part of the island is 850 feet long, with a greatest width of 75 feet; some of the trees growing on it are as large as those found in the forests on the river banks.

An abandoned plantation on the right bank, which formerly extended from the mouth of Petite Prairie Bayou to below Wiltsey's Island, was originally cultivated without levee protection; afterwards the removal of the raft necessitated the building of levees. The high-water of 1874 was 2.5 feet above the top of them, and indicated that the high-water of that year was more than 8 feet above what it was when the river was rafted. The banks are caving on both sides.

Thirty-fifth mile.—Both banks on this mile are also caving. The shoalest section showed a low-water depth of 30 feet.

Thirty-sixth and thirty-seventh miles.—Eleven sections were sounded on these two miles, the shoalest of which gave 31 feet at low-water. Both banks are caving.

Thirty-eighth mile.—Bayou Blaylock enters from the east near the head of this mile. At low stage a little drainage-water enters the river from this bayou, but at high-water it, like all the others, is a run-out bayou. The shoalest section on this mile has a depth of 36 feet at low-water. with a least width of 400 feet.

Thirty-ninth mile.—There are many snags on this mile, although the shoalest section gave 32 feet at low stage. Log bottom was found on every section sounded, and both banks are caving.

Fortieth mile.—Both banks caving. The shoalest section of the five sounded on this mile gave a depth of 35 feet at low-water.

Forty-first mile.—Large plantations were in cultivation here up to 1874, levees having been built previous to that time. After the overflow of that year they were practically abandoned. The shoalest section sounded gave 31 feet low-water depth, and a width of 420 feet. Many snags are visible above the water, and remains of raft blocks were found on each section, covering quite half the width of the river.

Forty-second mile.—At the head of this mile is an island 600 feet long and 65 feet wide. Its foundation is old raft, on top of which there is a deposit of 10 feet or more of red soil. Large forest trees are growing on this island. The east channel was the one cleared out by the State when the improvement of the Atchafalaya was undertaken, and the depth through it at time of survey was 30 feet. That through the west channel is only 18 feet. Navigation is still dangerous, however, owing to projecting logs and snags. Half a mile below the island is the head of Alabama Bayou. Its discharge at the time of survey was 2,327 cubic feet per second, while that of the Atchafalaya, below the Alabama, was 14,413 cubic feet per second. The river at that time was 4.1 feet above extreme low. Four miles from the Atchafalaya, Bayou Alabama is closed by raft, and the water passes around this obstruction through bayous on its left bank to rejoin the Alabama about 1 mile below the raft. The river is 575 feet wide above the Alabama, and 380 feet wide below.

Forty-third mile.—On this mile seven sections were sounded, and the shoalest gave a depth of 32 feet at low-water, with a low-water width of 350 feet.

Forty-fourth mile.—Both banks caving. The width is about the same as for forty-third mile, and the shoalest section showed a depth of 33 feet.

Forty-fifth mile.—The width of the river in the large bend on this mile is 825 feet, and depth 85 feet at low-water. The shoalest section sounded gave 20 feet at same stage. The banks are caving fast, even under the points.

Forty-sixth, forty seventh, and forty-eighth miles.—Both banks caving. The shoalest cross-section gave 35 feet depth at low-water. The width is quite uniformly 300 feet throughout these three miles. The high-water marks of 1880 are above the surface of the land.

Forty-ninth mile.—Bayou Courtableau enters from the west at about the middle of this mile. At present, with a rise of 6 feet in the Atchafalaya during low water in the Courtableau, the water runs up the latter and passes out to the south through Run-out Bayou. When the contemplated dams are built, closing these, the water of the Courtableau will empty into the Atchafalaya, even during a 12-foot rise.

Fiftieth mile.—This mile has a number of short bends, caused by rapid and irregular caving of banks. Six sections were sounded, the shoalest of which showed a depth of 30 feet at low-water, the width at this stage being 250 feet.

Fifty-first mile.—There are three bends of 90 degrees on this mile, and the banks on both sides are caving rapidly, even under the points of the bends. Six sections were sounded, the shoalest of which gave a depth of 28 feet at low-water.

Fifty-second mile.—Both banks are caving fast. The shoalest section gave a depth of 26 feet at low-water. The least width was found to be 240 feet, although in some places, from extensive slides, it was 400 feet or more. At high-water the banks are everywhere covered.

Fifty-third mile.—The banks are caving on both sides. The narrowest place is 280 feet wide, and the shoalest section gave a depth of 36 feet.

Fifty-fourth mile.—Both banks caving. The shoalest section gave a depth of 40 feet.

Fifty-fifth mile.—Same as above, except that shoalest section gave a depth of 38 feet.

Fifty-sixth mile.—Both banks are caving. The Alabama returns to the river on this mile. The former was examined for 7 miles above the junction, soundings and topography being taken. It is not enlarging, and does not appear to have done so since the Atchafalaya raft was opened. Below the Alabama the Atchafalaya is wider and deeper than above; 42 feet was found on the shoalest section, with a least low-water width of 280 feet.

Fifty-seventh mile.—The shoalest section, taken at the lower end of a straight reach of 1½ miles, showed a depth of 36 feet and a width of 300 feet. Banks are everywhere below high-water mark, and no levees were found.

Fifty-eighth mile.—There are two long easy bends on this mile. Deep water was found throughout, and no place narrower than 300 feet.

Fifty-ninth and sixtieth miles.—The banks are everywhere caving. The shoalest section gave a depth of 42 feet.

Sixty-first mile.—The shoalest section gave a depth of 37 feet.

Sixty-second mile.—Shoalest section 35 feet deep. The left bank is very low for 4,000 feet. The right bank is higher, but below high-water mark.

Sixty-third and sixty-fourth miles.—An old sugar plantation occupies the left bank, but is not now in cultivation. The high-water of 1880 was a foot above the highest part of the fields, while that of 1874 was 2 feet higher than that. The shoalest cross-section gave a depth of 37 feet at low-water.

Sixty-fifth mile.—Both banks are caving. The shoalest section gave a depth of 41 feet at low-water.

Sixty-sixth mile.—At the head of this mile the Atchafalaya turns with a sharp bend to the east and enters the head of Grand River at Butte la Rose. The width of the Atchafalaya at its entrance is 260 feet, and its depth 44 feet. The width of Grand River just below is 850 feet, and its depth 44 feet. The extension of Grand River beyond the Atchafalaya to the westward receives the water from the run-out bayous of the Courtableau. Butte la Rose is an ancient shell mound on the south side of Grand River. During the war Fort Burton was built on it. It is the only place in this section above high-water. Grand River is properly the continuation of the Atchafalaya, and the survey was continued down it in the direction of the Plaquemine, leaving the bayous connecting to the southward with Lake Mongoulois, &c., to be examined afterwards. The Little Atchafalaya runs out of Grand River to the south, near the end of this mile. It is about 125 feet wide and very crooked. It is not used for navigation.

Sixty-seventh mile.—The width throughout this mile is about 400 feet, and the depth at low-water 45 feet. A willow batture, from 100 to 250 feet wide, and grown up with young willows, is found all along the left bank for this and the 3 miles below, showing that the channel has contracted somewhat in late years.

Sixty-eighth and sixty-ninth miles.—Both banks are overflowed at high-water, so that the land formerly cultivated on the right bank has been abandoned. The width in the narrowest place is 380 feet at low-water, and the depth at same stage found on the shoalest section is 45 feet.

Seventieth mile.—The depth on shoalest section was found to be 54 feet at low-water, and least width at same stage 370 feet.

Seventy-first mile.—Near the head of this mile Bayou la Rompe runs out to the south. Discharge measurements were made in the Rompe, and in Grand River just below it, with the following results: La Rompe, 20,073 cubic feet per second; sectional area, 6,200 square feet. Grand River, 16,040 cubic feet per second; sectional area, 9,475 square feet; 1,900 feet below its head Bayou la Rompe is joined by the Little Atchafalaya. Grand River below Bayou la Rompe is about 300 feet wide.

Seventy-second mile.—The left bank for 600 feet from the head of this mile is formed by a narrow point between the river and Ouski Bay;

thence for 1,800 feet is the open lake called "Oxa" on Captain Leavenworth's chart, but universally known as Whisky Bay by the inhabitants and steamboat-men.

Seventy-third mile.—The river is 1,000 feet wide at the head of this mile, with a depth at low-water of 25 feet, but at the end of the mile narrows to a width of 500 feet, and increases in depth to 45 feet.

Seventy-fourth mile.—The left bank is bordered by a cypress swamp, and the right by fields once cultivated but now abandoned.

The width is nowhere less than 500 feet, and the shoalest section gave a depth of 35 feet.

Seventy-fifth mile.—The width and depth continue as on the seventy-fourth mile. At the lower end Big Tensas Bayou runs out to the south. Its width is 220 feet and depth 25 feet 200 feet below its head. A cross-section taken 200 feet above the head of Bayou Tensas, and another just below it, show a width of 600 feet in each case, but the depth below is 8 feet less than that found above.

The right bank above and below the Tensas is comparatively high, but not above overflow.

Seventy-sixth mile.—This mile has about the same width as the one above, with 32 feet on the shoalest section. Second Tensas leaves the river on the right bank about the middle of the mile. It is about 120 feet wide, but very shoal, and much obstructed by raft.

Seventy-seventh mile.—Third Tensas runs out through the right bank at the head of this mile, and fourth and fifth Tensas near the lower end. These bayous are from 50 to 60 feet wide, and all are much rafted and very shoal. A large amount of water runs out through them during floods, but very little at low-water. The entire left bank is bordered by a cypress swamp.

Seventy-eighth mile.—Here the river shoals to 18 feet at low-water, but its width continues about 600 feet. Sixth Tensas runs out at the head of the mile. It is 25 feet wide, but rafted near its head. Below, the seventh, eighth, and ninth Tensas leave near each other. They are each about 100 feet wide, but rafted, so that at low-water they are practically closed. Tenth or Little Tensas is the lower one of these bayous, and is the only one now used for navigation; it is 120 feet wide and 18 feet deep at low-water, and is said to have cut out a great deal in the last few years. The left bank of the Grand is bordered by a cypress swamp.

Seventy-ninth mile.—The width remains about 600 feet, and on the shoalest section 15 feet was found at low-water. Six small bayous leave the river on the right bank, and two enter on the left.

Eightieth mile.—Four small bayous leave to the south. All are shoal. The width and depth of the river remain about the same as on the seventy-ninth mile.

Eighty-first mile.—Three small bayous run out to the south at the head of this mile, and near the end of it Bayou Little Pidgeon also leaves in the same direction. It was once navigable for swamp-boats, but is now rafted and closed.

Eighty-second mile.—The left bank is low and swampy. Along the right bank seven old bayou channels are found, which are more or less rafted.

Eighty-third mile.—The width is from 250 to 300 feet, with a depth of 28 feet on the shoaled section. Eight small bayous run out through the right bank. A 6-foot rise overflows the banks.

Eighty-fourth mile.—Ten small bayous run out on the south side. The north bank is along a cypress swamp. Traverse Flat, an open lake, is at the middle of the mile.

Eighty-fifth mile.—Bayou Maringouin enters the river here; it comes from the Mississippi at Morganza, but brings only drainage-water, except when the Mississippi is high, and water comes through Grand Levee Crevasse. Bayou Maringouin is 220 feet wide and 15 feet deep; its banks are low, mostly swampy. A bayou 50 feet wide runs out of Grand River, directly opposite the mouth of the Maringouin; it is rafted and has little current except during high-water.

Eighty-sixth mile.—There are five small run-out bayous on the south bank of this mile. At time of survey, with a stage of water 2.3 feet above zero, the north bank and half of the south bank were overflowed. The shoalest section gave a depth of 17 feet, and the narrowest place was 280 feet wide.

Eighty-seventh mile.—The depth down to the middle of this mile is 13 feet at low-water, but the last half of it shoals to 8.7 at same stage. The banks were under water at a stage 2.3 feet above extreme low. Here the "Narrows" commence, which were caused by the rafting of Lower Grand River and Bayou Sorrel, when Bayou Plaquemine was opened. Closing the lower outlet turned the water up this channel, and at the end of this mile is the upper block of raft that has floated in here from the Plaquemine. A narrow channel has been cleared out, but at the head of the

Eighty-eighth mile it is only 80 feet wide and 8 feet deep in the deepest part. Some of the trees growing on the rafted material are fifteen years old, and pilots state that formerly there was no raft or contraction of channel here. Narrow as the channel between the batture and tow-heads is, 50 feet or less, it is much choked by overhanging willows. The stage of water at time of survey was 1.8 feet about zero, yet both banks were covered fully a foot deep everywhere within sight.

Eighty-ninth mile.—This mile, like the one already described, is much obstructed by tow-heads, which have narrowed the channel very materially; in addition, the overhanging willows which have grown upon the tow-heads and battures now form a serious impediment to boats attempting this route. The old banks of the river, as they existed prior to the rafting period, show that the stream was once of practically the same dimensions here as above. The shoalest place in the principal channel, which is between the tow-heads and the right bank, has 8 feet through it at low-water, with a width of from 50 to 60 feet. The current at the time of survey was very sluggish, a free float moving in the narrowest places only about 10 or 12 feet per minute.

Ninetieth mile.—The condition of this mile is very much the same as that of the eighty-ninth, except that the depth is 9 feet.

Ninety-first mile.—The width of river is about 100 feet, and the depth 10 feet on the shoalest section. A batture from 200 to 300 feet wide extends along the north bank. About the middle of the mile a swamp-drainage bayou 90 feet wide enters from the north, and below its mouth the current in the river is from 40 to 50 feet per minute.

Ninety-second mile.—At the head of the mile are two tow-heads, which narrow the bayou to 40 feet, and this channel is covered in completely by overhanging trees. The shoalest section gave a depth of 13 feet at low-water.

Ninety-third mile.—The channel is much obstructed by overhanging trees and tow-heads. The shoalest section gave a depth of 11 feet at low-water. At the end of this mile the river widens out and is joined by the Plaquemine; below the junction, known as the "Park," it is called Lower Grand River. A pile breakwater was once built here to force the drift that came down the Plaquemine previous to its closure into the

Lower Grand, but eventually this stream became choked with raft, and then the direction of the current was through the Upper Grand, carrying the drift with it. As a result of this, there is to-day the raft blockade extending 5 miles up the Upper Grand.

LOWER GRAND RIVER.

First mile below mouth of Plaquemine.—About 1,500 feet below the Plaquemine is an old abandoned railroad bridge, through which the steamboatmen have torn out a passage-way 60 feet wide for boats. The shoalest section on this mile shows a depth of 20 feet, and the narrowest place is 200 feet wide. The land on both sides of the river was formerly cultivated, and an old levee still exists on the left bank; the top of it is, however, considerably below high-water mark.

Second mile.—The width on the river is everywhere 200 feet or more, and the shoalest of the six sections sounded gave a depth of 22 feet. A small bayou enters from the left, but with a slight rise in the Grand the current is from the river into the swamps. The lands on both banks were formerly cultivated, but, owing to increased height of flood-line, have been abandoned.

Third mile.—The least width on this mile is 200 feet; depth of shoalest section 14 feet. The banks are now overflowed at high-water everywhere.

Fourth mile.—The least width is 200 feet, and depth on shoalest section sounded 20 feet. Both banks are covered with overhanging willow trees.

Fifth mile.—Same as for fourth mile, except that the depth on shoalest section was 18 feet.

Sixth mile.—At the middle of this mile the river divides, Bayou Sorrel running to the right into Lake Chicot, and the Grand turning to the southeast. Mr. Rivet, who lived here from 1840 to 1860, states that in 1851 the Grand below the Sorrel was as wide as it was above, and that the latter was but a small bayou. The Grand was rafted by the drift from Bayou Plaquemine, and is so completely filled with logs and mud that at low-water it is nearly dry. Bayou Sorrel, which commences at about the middle of the sixth mile, is now the continuation of the Grand for all purposes of navigation; its width at low-water is about 140 feet in narrowest places, and available depth 19 feet.

Seventh mile.—The width is 150 feet in narrow places, and depth of shoalest section 18 feet. An ancient mound 100 feet in diameter and 14 feet above high-water mark is near the middle of the mile on the left bank. While Lower Grand River was navigable for steamers previous to the formation of the raft, Bayou Sorrel was closed by blocks of raft, which were removed before the war by the State snag-boat. The overhanging trees and a few snags are now the only obstructions.

Eighth mile.—The condition of this mile is about the same as that of the seventh.

Ninth mile.—The width in narrow places is 120 feet, but the depth is 24 feet on shoalest cross-section. Cannon Bayou, which is 60 feet wide and 7 feet deep at its head, runs out near the end of the mile. It widens to 100 feet within a short distance, but is much choked by drift. Its banks are from 7 to 7½ feet high and the levee is 3½ feet, yet the high-water mark is high above it.

Tenth mile.—The width is 120 feet and the depth on shoalest section 23 feet.

Eleventh mile.—The least width is 150 feet and the depth on shoalest section 22 feet. Barry's Bayou enters from the north about the middle of the mile; it is 70 feet wide and has a strong current, bringing in the drainage-water from the swamps. The south bank is leveed and the lands on both sides were once cultivated, but are now abandoned on account of overflow.

Twelfth mile.—The width is 170 feet and depth 20 feet on shoalest section.

Thirteenth mile.—Width and depth same as for last mile.

Fourteenth mile.—Width in narrow places 140 feet, and depth on shoalest section 21 feet. Pigeon Lake Bayou enters from the right near the end of the mile; its width is 150 feet and its depth 22 feet. At the time of survey the discharge of this bayou was greater than that of the Sorrel above the junction.

Fifteenth mile.—The depth of shoalest section on this mile is 33 feet.

Sixteenth mile.—Fifteen hundred feet below the head of this mile Bayou Sorrel enters Bayou Sorrel Bay, with but 8 feet on the bar at its mouth. The width of the bay is 650 feet, and it is much obstructed with raft and snags. The passage through it is near the right bank, and all soundings show log bottom. Near the end of the mile a block of raft extends out from the left bank more than half-way across the bay, rising from 5 to 10 feet above low-water.

Seventeenth mile.—On this mile there is a broken line of old raft and tow-head islands with raft foundations, and among the logs and through openings between tow-heads much water finds its way to the left bank, forming a channel which from here down to the lake follows the left bank. For the upper half of the mile there is a good channel along the right bank 20 feet deep and 150 feet wide. Below there is but 5 feet at low-water on one hundred and eighteenth cross-section with log bottom. The steamboat channel at low-water is up Lake Chicot to Bayou Chène, up that to Jake's Bayou, thence to Rigarby Bayou and down it to the head of Bayou Sorrel Bay, about 6 miles, the low-water depths being not less than 5 feet. By clearing the raft out of Bayou Sorrel Bay this tortuous course could be avoided and the distance from Lake Chicot to Bayou Sorrel materially shortened.

As stated at the commencement of this report, the operations of the survey were here suspended, owing to high-water. In September, 1881, Assistant Engineer Hoffman completed the work by surveying the run-out bayous that connect Grand River with Lake Chicot and Grand Lake, commencing with the Little Atchafalaya. The following is taken from his report:

Little Atchafalaya is the first of the run-out bayous, and is found on the sixty-sixth mile (Atchafalaya survey), where the Atchafalaya River ends and Grand River commences. It flows east for a distance of 3.4 miles and empties into La Rompe about one-half mile from the head of the latter. It, at the time of survey, was not navigable, being blocked with fallen trees. The width of the bayou between its regular banks is 150 feet, and least depth 9 feet, but during high-water in the Atchafalaya the banks are under water. The bayou is lined with overhanging trees and both banks are caving.

Bayou La Rompe leaves Grand River on the seventy-first mile and flows southeast for a distance of 9 miles, emptying into Lake Mongoulois. From its head to Devil Chute, a distance of 5.7 miles, it is 450 feet wide, with a good clear channel having 10 feet least depth. The banks for the first half mile and on the fourth mile are comparatively high and partly cultivated; in other places they are swampy and covered with overhanging trees. Near the end of the fourth mile are two bayous which carry off a portion of its water to Lake Fausse Point. From Devil Chute to its mouth the bayou narrows to about 175 feet, a great portion of the water going out to the swamps over the west bank. A portion of this water returns to the bayou near the end of the eighth mile, increasing its width to 500 feet; the depth of channel at this point, eighth mile, is 7 feet; below here it shoals to 3 feet to the lake, but it is often only 2 feet deep. The course of the bayou is mostly through a cypress swamp; at its mouth there is a sand bar formed of Mississippi River deposit, with many logs imbedded in it. Devil Chute connects Bayous La Rompe and Big Tensas, flowing into the latter; it is 800 feet long, 150 feet wide, and has a good clear channel of 20 feet depth. Bayou Big Tensas leaves the Grand on the seventy-fifth mile and flows in a south southeast direction into Lake Mongoulois; it is 5 miles long. From its head to Devil Chute it averages 200 feet in width, and has a least depth of 15 feet; the banks at Grand River are comparatively high for half a mile. Below this point they are low and swampy and bordered with trees overhanging the stream. In this portion of the bayou there are two islands which are caving away. Below Devil Chute the bayou has a width of 400 feet; the banks are low and swampy. There are two outlets through the east bank into Lake Mongoulois before reaching the mouth proper, but they are small and blocked by obstructions. The bar at the mouth is similar in its formation to that at the mouth of La Rompe.

Little Tensas is the last and smallest of the bayous of this name, and the one now used at extreme low-water. It leaves Grand River on the seventy-eighth mile and runs south a distance of 2½ miles, a portion of its waters flowing into Lake Mongoulois and the balance into Bayou Rigarby. At its head the bayou is 100 feet wide and 18 feet deep.

The east bank for the first mile has been cultivated, while the west bank is cane-brake; below the first mile the land on both sides is low and swampy. The east bank is cut up by little bayous running into the swamp; both banks are caving and covered with overhanging and fallen trees. About 1½ miles from its head the bayou widens out into Tensas Bay, receiving a large body of water from the other Tensas bayous. The bay has a 5-foot channel through it, either to the lake (Mongoulois) or Bayou Rigarby; but it is dangerous, owing to logs left from the raft. The pass into Lake Mongoulois is deep and good; it is about 1,280 feet long, with high banks. Lake Mongoulois receives the waters of Bayous La Rompe, Big and Little Tensas; it is half a mile wide and 3 miles long; at its head it is supplied with water from Little Tensas and a few of the small bayous, while La Rompe and Big Tensas empty into it on the west bank. The eastern bank is cypress brake, and Bayou Chène forms its southern outlet, with a good 12-foot channel.

The upper end of the lake is much obstructed by logs, and has an average depth of 5 feet. Bayou Chène connects Lake Mongoulois with Lake Chicot, and is 5 miles long. The banks for the first 3 miles are above ordinary high-water, and prior to 1874 were cultivated; below this they are low, with overhanging trees. This bayou at its head is nearly 520 feet wide, with a good clear channel of not less than 20 feet depth to the head of the Crook Chène, just below the end of the first mile. Between this point and the head of Bayou Tarleton, end of second mile, the Chène is 340 feet wide and 30 feet deep. Between the second and fourth miles the bayou is 200 feet wide and 30 feet deep. Jake's Bayou enters the east bank on the fourth mile, and one bayou leaves by the west bank on same mile. Near the mouth the bayou is 270 feet wide and 37 feet deep, but shoals to 6 feet into Lake Chicot.

Bayou Rigarby begins at the lower end of Tensas Bay and flows into the Sorrel; it is 7.8 miles long. The banks are low and swampy, except for 1½ miles, beginning at the end of the fifth mile; here the banks are so high that the land was formerly cultivated. The width is 200 feet and least depth 5 feet for the first mile. On the second mile the width is less, but the depth increases to 10 feet. On the third mile there are two openings into Lake Mongoulois, through which considerable water comes, and as a consequence the bayou below for 1 mile is considerably wider; then, as considerable water passes off to the south through a little bay, the bayou becomes narrow again. From the third mile there is a 20-foot channel to the Sorrel. At the end of the fifth mile Jake's Bayou takes off considerable water into the Chène. This bayou is 1.7 miles long; the banks are above ordinary overflow, and covered with overhanging trees. The width is from 250 feet at the head to 140 feet at the lower end, and the depth throughout not less than 18 feet. Lake Chicot receives all the water from the Atchafalaya between Butte La Rose and Bayou Sorrel, and discharges into Grand Lake. It is 3 miles long and about 1.6 miles wide, surrounded by cypress swamps, and has a 5-foot channel to Pass Chicot, which, however, is much obstructed by logs. Pass Chicot is 450 feet wide and a half mile long, and 20 feet deep.

The several bayous furnish six routes for steamboat navigation, depending on the stage of water, between the Atchafalaya (sixty-sixth mile) and Lake Chicot, viz:

	Miles.
Little Atchafalaya, La Rompe, and Chène	19.4
Grand River, La Rompe, Devil Chute, and Chène	19.7
Grand River, Big Tensas, and Chène	21.5
Grand River, Little Tensas, and Chène	23.0
Grand River, Little Tensas, Rigarby, and Sorrel	24.3
Grand River, Little Tensas, Rigarby, and Jake	21.2

As the raft in the Atchafalaya is cut out at each high-water, the material forming it passes down stream, some of it finding its way into Grand Lake, and some, being caught in the bayous connecting the river and lake, forms new obstructions to navigation or adds to those already existing; in consequence, many changes are liable to occur at each high-water, and a route practicable during the low-water of one year might during that of the following year be worthless.

The shortest route from the Upper Atchafalaya to Grand Lake is down Bayou La Rompe. At the time of survey steamers could not pass this way except with a rise of 7 feet above low-wator, on account of the bar at the entrance of the bayou into Lake Mongoulois. To make this route available at low-water, it is thought that the construction of five dams to close run-out bayous will be necessary. By doing this the water entering the bayou at its head will be concentrated on the bar, it is expected, sufficiently to scour out a channel of navigable depth into Lake Mongoulois. It is possible that more works will be needed, but only after the effect of the five proposed closures is known will it be safe to locate them.

The following is the estimate for opening this route:

Five dams	$30,179 00
Clearing banks 21 miles, at $100	2,100 00
Contingencies, 20 per cent	6,455 80
Total	38,734 80

The present route at lowest water is by way of Little Tensas, and the bayous of this route are nearly separated from Lake Mongoulois. The proposed plan is to close the four remaining openings which connect with the lake, and for removal of the trees from the banks, so that the bayous, which are now increasing in size from caving of banks, will not be obstructed by overhanging trees.

The following is the estimate for clearing out this route:

Four dams	$14,500 00
Clearing banks 24 miles, at $200	4,800 00
Contingencies, 20 per cent	3,860 00
Total	23,160 00

In case locks are constructed at the head of the Plaquemine to connect Grand River with the Mississippi, the route which would be used almost entirely would be down Grand River to the Plaquemine, and the Attakapas trade would go down Lower Grand River and Bayou Sorrel to Lake Chicot. The navigation by this route would be fully as good as that by Little Tensas. Though the cost of improving this route would be considerably greater than that of either of the other two, the fact that they would be practically of no account in case of a change to the Plaquemine connection with the Mississippi might make it advisable to improve this longer route instead of either of the others, as the whole work would be necessary in case the change mentioned above was made.

The estimate for this work is $92,604.40.

Some other small works might be found necessary, but, if so, could be made after the main work of the improvement was finished and the effect known.

ESTIMATE FOR UPPER GRAND AT THE NARROWS, 5 MILES.

Clearing both banks 5 miles, back 75 feet	$2,000 00
Dredging tow-heads, 5,500 feet long, average width 60 feet, depth 12 feet, 146,666 cubic yards, at 20 cents	29,333 33
Total	31,333 33
Contingencies, 20 per cent	6,266 67
	37,600 00

To clear a full width for the whole length of the "Narrows" to enable steamers to pass anywhere, 400,000 cubic yards of dredging in addition to the above would be required. In all probability this would not be required, as boats would be able to pass each other every mile or so with the 60-foot cut, and the tendency would be towards an increase of width from scouring.

ESTIMATE FOR LOWER GRAND RIVER AND BAYOU SORREL TO CONNECT WITH LAKE CHICOT CHANNEL IN DEEP WATER.

Removal of overhanging trees on one side of Lower Grand River, 5½ miles.	$550 00
Removal of trees on Bayou Sorrel, both sides, 10 miles, at $200	2,000 00
Dredged cut through log pile, 1,000 feet long, 200 feet wide, 35,000 cubic yards, at 75 cents per yard	26,250 00
Dam, 2,000 feet long, 51,111 cubic yards, at 33⅓ cents	17,037 00
20 per cent. contingencies and engineering	9,167 40
Total	55,004 40
Upper Grand River	37,600 00
Grand total	92,604 40

Appended hereto is a list of bench-marks and elevations of bank and water surface.*

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* Not printed.

This survey was made in the summers of 1880 and 1881, being between the great floods which occurred in the springs of 1874 and 1882. It is proper to note that this last flood has undoubtedly made a very material change in the river since the survey, not only with regard to the location of the channel, but with the amount of water which passes down the river. Ever since the partial removal of the raft each recurring flood has made an increase in the amount of water entering the river, and has caused the abandonment of cultivated lands. The levees which were constructed after the flood of 1874 were found utterly inefficient during the recent flood.

Capt. D. W. Lockwood, Corps of Engineers, who passed into the Atchafalaya on the 10th of last March, reports that on that day the Atchafalaya at its head was apparently filled with Mississippi River water, no Red River water showing on the surface, the latter passing over the country to the west and gradually showing itself in the Atchafalaya, so that at Simmsport, about 5 miles from the head of the Atchafalaya, about one-third of the latter appeared to be Red River water. There is no doubt in my mind that unless some action is taken soon to control or limit the influx of water, the Atchafalaya will so enlarge as to have a very marked effect upon the Mississippi River, and cause the abandonment of a very considerable area of cultivated land between Bayous Lafourche and Teche.

During the present flood the water at Charenton, on the Teche, on April 13, reached a point 12 feet 1½ inches above medium tide, being 5 feet above the flood of 1874 and 9½ inches above the highest point of land between the Teche and Grand Lake.

It is evident that no plan for improving the Atchafalaya, further than that already mentioned, is worth considering until something definite is done at the head; and as this is intimately connected with the Mississippi River problem, I have no recommendations to make until the Mississippi River Commission shall have taken action.

A tracing of the chart in eleven sheets accompanies this report.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

M 20.

EXAMINATION OF BAYOU GRAND CAILLOU, LOUISIANA.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., April 25, 1882.

GENERAL: I have the honor to submit the following report of Assistant Engineer H. S. Douglas on the examination of Bayou Grand Caillou, Louisiana, together with a tracing of the chart. The recommendations of Mr. Douglas, with regard to extent, method, and cost of improvement, are concurred in.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. H. S. DOUGLAS, ASSISTANT ENGINEER.

NEW ORLEANS, *March* 29, 1882.

SIR: The following report on the examination of Bayou Grand Caillou, Louisiana, is respectfully submitted.

In obedience to the instructions of Maj. C. W. Howell, after the examination of Bayou Black had been completed, I had party and outfit transferred to Bayou Grand Caillou. Material assistance in the way of transportation, &c., was furnished me by Messrs. H. C. Minor and D. S. Cage.

The initial point of the examination line was taken at the bridge of the Woodlawn Plantation, and from that point to the mouth of the bayou in Caillou Bay, a distance of 38 miles, a careful examination was made. No accident or delay worthy of mention occurred, and the field work was completed in nine days, from May 25 to June 2, inclusive.

The method of conducting the field work was the same as on Bayou Black. Bayou Grand Caillou must at one time have been quite a large sediment-bearing stream, as the present width of its original channel is from 400 to 600 feet, and the strip of alluvial land between either bank and the swamp is wide and high. Its connection with the Mississippi River was via Bayous Lafourche and Terrebonne, leaving the latter bayou at about the point where the town of Houma is now located. The decadence of this bayou may be traced to the same causes as have almost closed the Terrebonne and the Black. When it ceased to be an outlet of the Mississippi it became a tidal bayou, with only a slight current, occasioned by the ebb and flow of the tide and the local drainage. This current was not sufficient to keep the cut grass and weeds from encroaching on the open channel, and the drainage from cultivated lands carried in a large amount of sediment which, the slight current being unable to carry off, settled to the bottom and assisted the other causes at work to close the bayou as a navigable stream. At present the upper portion of the bayou is nothing but a willow swamp. Above the commencement of the present examination this swamp grows gradually narrower until it ceases to exist even as a ditch, and the plow is run clear across what was the former bed of a large bayou, now only indicated by a slight depression from the general level of the land. The following is a detailed description of that portion of the bayou covered by the examination line:

First, second, and third miles.—The bayou is nothing but a willow and cypress swamp, from 300 to 400 feet wide, with no trace of an open channel. The bottom is an exceedingly soft mud, covered with from 1 to 3 feet of water, and supporting a thick growth of cut grass and aquatic plants. The banks on either side are sugar plantations.

Fourth and fifth miles are about the same, except that there are slight indications of an open channel meandering the swamp.

Sixth mile.—At the commencement of this mile Bayou Pelton enters from the west. This bayou is one of the drains of the swamp lying between Bayous Grand Caillou and de Large. Below its junction with Grand Caillou there is an open channel, 4 to 6 feet deep and 20 to 30 feet wide. I was informed that the bayou had been partially cleared out up to this point. This open channel meanders the swamp, which is from 500 to 660 feet wide, but never quite touches the high land on the edge of the swamp. Near the end of this mile Bayou le Carp, another swamp-drain, enters from the west.

Seventh, eighth, and ninth miles.—The open channel has a depth of 5 to 7 feet and width of 30 to 50 feet. The banks, with the exception of the last half of the ninth mile, are overhung with live-oaks. Swamp varies from 400 to 600 feet in width, and the lands on both banks are cultivated in sugar-cane.

Tenth, eleventh, and twelfth miles.—Open channel has a depth of 6 to 8 feet, and width of 40 to 80 feet. There are few obstructions, and the swamp, which is from 300 to 400 feet in width, is much more open and becomes more of a marsh than a swamp.

Thirteenth mile.—The water commences to be salt, and the floating grass which exists in the bayou above ceases. Channel from 5 to 7 feet deep, and 80 to 150 feet wide. Both banks cultivated.

Fourteenth mile.—Bayou du Lac, a larger bayou than Grand Caillou, enters from the east. It is the outlet of Lake Quitman, a large sheet of water lying in the marsh between the two Caillous, and from it a canal has been cut into Little Caillou, thus connecting the two bayous. At the junction of the du Lac there is a bar in Little Caillou on which there is only 3 feet of water at low-tide. This bar is about 300 feet long, and is composed of soft mud. Below this the bayou has a width of 150 to 200 feet and a depth of 11 to 20 feet.

The swamp ceases, and there is only a strip of marsh between the water's edge and the high banks. The current runs either way, depending upon the tide.

Fifteenth, sixteenth, seventeenth, and eighteenth miles.—Bayou averages about 200 feet in width by a depth of from 12 to 17 feet. The strip of high land on either bank narrows down until it is only from 200 to 300 feet wide, back of which is the sea marsh. This strip of land is generally under cultivation. Near the end of the sixteenth mile

Bayou la Cere enters from the east, and on the seventeenth mile Mound Bayou enters from the west.

Nineteenth to thirty-eighth mile, inclusive.—The high banks grow less until they finally merge into the sea marsh, which is intersected by numerous lakes, bayous, and lagoons, the addition of which increase the bayou in width until it is from 800 to 1,000 feet wide by a least depth of 12 feet. From the twenty-fourth mile to the mouth it is nothing more than a sea-marsh bayou.

Bayou Grand Caillou debouches into Caillou Bay, an arm of the Gulf of Mexico. There is no bar at its mouth, but I am informed that there is only from 6 to 7 feet of water in Caillou Bay. Mr. Luke, a pilot in these waters, informed me that vessels entering or leaving Grand Caillou never drew more than 7 feet. All the general information contained in the report on the examination of Bayou Black, in reference to cut grass, logs imbedded in the bottom of the bayou, &c., will also apply to Grand Caillou, and to avoid repetition I respectfully refer to that report.

COMMERCE.

No very detailed information in regard to the commerce to be benefited by the improvement of this bayou could be obtained.

In the year 1880, about 3,500 hogsheads of sugar and 5,000 barrels of molasses, with the usual miscellaneous country produce, were raised on Bayou Grand Caillou.

IMPROVEMENTS.

As the general characteristics of Bayous Black and Grand Caillou are identical, the same plan of improvement is submitted for the latter as for the former, viz, to dredge a tide-water channel, 4 feet deep and 30 feet wide, from the junction of Bayou Pelton to the Woodlawn plantation, a distance of 5 miles; remove overhanging trees, straighten abrupt bends, and dredge out all shoals as far as the junction of Bayou du Lac. The parties interested seem to be of the opinion that a 4-foot channel will be sufficient for all vessels likely to navigate the bayou.

The following is an estimate of the cost of the proposed improvement, based upon the cost of the work already done in Bayou Terrebonne:

Dredging channel 4 feet deep, 30 feet wide, for 5 miles, at $1,200 per mile.....	$6,000
Removing overhanging trees and other obstructions, straightening abrupt bends, and deepening shoals for 8 miles, 1,000 feet, between Bayous Pelton and du Lac, at $400 per mile	3,280
	9,280
Add 10 per cent. for contingencies	928
	10,208

Should the proposed improvement be carried out, parties owning land on the bayou should be prevented from running their drainage ditches into it, as bars would be sure to form at the entrance of all such drains, and would require to be constantly dredged out. The natural drainage is back towards the swamps.

A chart on the scale of $\frac{1}{5000}$ accompanies this report.

Very respectfully, your obedient servant,

H. S. DOUGLAS,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

M 21.

EXAMINATION OF BAYOU LITTLE CAILLOU, LOUISIANA.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., April 24, 1882.

GENERAL: I have the honor to submit the following report of Assistant Engineer H. S. Douglas on the examination of Bayou Little Caillou, Louisiana, together with a tracing of the chart.

The recommendations of Mr. Douglas, with regard to the improvement of this bayou, and the estimate of cost, are concurred in.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. H. S. DOUGLAS, ASSISTANT ENGINEER.

NEW ORLEANS, *April* 1, 1882.

SIR: I have the honor to submit the following report on the examination of Bayou Little Caillou, Louisiana.

Immediately upon the completion of the work on Grand Caillou, I embarked my party and camp equipage in the three skiffs which had transported us thus far, and after a rather dangerous voyage of about 35 miles through the bays and lakes lying between Last Island and the main land, arrived safely on the banks of Little Caillou. The examination of Little Caillou was commenced on June 6 and completed on June 10. Total lengths of bayou examined, 28 miles 1,500 feet. The field work was conducted in the same manner as on Bayou Black. The line was commenced at a point in the sea marsh where the shoalness and narrowness of the bayou seemed to preclude navigation, and continued as far up as the bridge of Brown's plantation, above which parties interested in the improvement of the stream did not consider it necessary.

As a general description of Little Caillou would be but a repetition of that already given for Bayous Black and Grand Caillou, it is omitted.

Like them it was at one time an outlet bayou of the Mississippi River, via the Lafourche and Terrebonne, leaving the latter bayou at a point 4¼ miles south of the town of Houma. It has ceased to be navigable for like reasons, and it is at present in about the same condition.

The following is a detailed description, by miles, measured in the direction in which the examination was made:

First, second, third, fourth, and fifth miles.—Little Caillou is a sea-marsh bayou with numerous bayous intersecting, and bays opening into, it. It is deep or shoal, narrow or wide, dependent upon the tidal currents between the bays which it connects, varying from 60 to 350 feet in width, and from 2 to 11 feet in depth. Bayou Couteau, an opening on the east, near the end of the fifth mile, is the channel generally used by any craft coming down the bayou that far, to make their exit from Little Caillou.

Sixth, seventh, and eighth miles.—The banks are slightly above the general level of the sea marsh, and have live oaks growing on them. Bayou 120 to 150 feet wide, and 3 to 4 feet deep.

Ninth mile.—Average width 140 feet, by a depth of 4 to 6 feet. The high land between the bayou and the sea marsh is about 100 feet wide, and is partially under cultivation. On the east bank, near the beginning of this mile, is Mayo's Cut-off, a canal opening into one of the arms of Terrebonne Bay; and 400 feet above it, on the west bank, is Big Cocodrie, a sea-marsh bayou.

Tenth, eleventh, twelfth, thirteenth, and fourteenth miles.—Bayou averages from 110 to 150 feet wide, by a depth of 6 to 8 feet. High banks grow wider, and are more thickly settled.

Fifteenth mile.—There commences to be a strip of marsh between the bayou and the high banks. On the west bank is Robinson's Canal to Lake Quitman, now closed by a dam. Bayou 100 feet wide and 4.5 feet deep.

Sixteenth, seventeenth and eighteenth miles.—The bayou decreases gradually to 50 feet in width by a depth of 5 feet. Marsh about 250 feet wide from high bank to high bank. Cultivated lands on both sides of bayou.

Nineteenth mile.—On the east bank near the beginning of this mile is the Lacache Canal, which connects Little Caillou with Bayou Lacache, and through it with the Terrebonne. Through this canal the principal part of the commerce of Little Caillou passes. Near the end of the mile, on the west bank, is Boudro's Canal to Lake Quitman, and thence to Grand Caillou. From the entrance of this canal to nearly the end of the twenty-fourth mile the bayou has been improved by the dredging of a channel, with a least width of 25 feet and least depth of 4 feet. This work has been done by private enterprise, and has already been of great benefit.

Twentieth, twenty-first, twenty-second, twenty-third, and twenty-fourth miles.—Dredged channel ends at 23 miles 3,900 feet, and beyond it the bayou is practically closed.

The influence of the tide is felt to this point. Sugar plantations on both banks. Marsh 200 to 250 feet wide.

Twenty-fifth mile.—Bayou choked with cut grass and water-weeds, which act as a dam, retaining the waters above. Marsh 150 to 200 feet wide, with a few willows growing in it.

Twenty-sixth mile to end of examination line at 28 *miles* 1,500 *feet.*—Bayou is a soft marsh, with willows and a few palmettoes growing in it. There are occasional open pools of water, but it is mostly grown up with cut grass and water-weeds. Above this it was not thought necessary to continue the examination, as the bayou grew very much worse.

No definite information as to the commerce of this bayou could be obtained, but as it traverses a thickly settled district, it is thought that it would be equal to that of Grand Caillou.

It is probably the intention of the parties interested in the improvement of Grand and Little Caillous to have them act as feeders of the through route from New Orleans to the Atchafalaya. This route is as follows: New Orleans to Barataria Bay by several canals and bayous; Barataria Bay to Bayou Lafourche by canal; Bayou Lafourche to Bayou Terrebonne by canal; Bayou Terrebonne to Bayou Black by canal; and thence to the Atchafalaya. At present vessels can and do go from New Orleans to Bayou Terrebonne by this route. Further information in reference to this will be found in the "report on the survey and examination of Barataria Bay, &c.," and in the "report on the examination of Bayou Black."

IMPROVEMENT.

The same method is suggested as for Grand Caillou, viz, to widen the channel already excavated from Boudro's Canal to near the end of the twenty-fourth mile to 30 feet, and remove all obstructions from it. Above that point to dredge a 4-foot channel 30 feet wide to the end of the examination line, a distance of 4 miles 2,900 feet.

The following is an estimate of the cost of the improvement, based upon the cost of the improvement of Bayou Terrebonne:

Widening existing channel to 30 feet and removing all obstructions 4 miles, at $300 per mile	$1,200
Dredging channel 4 feet deep, 30 feet wide, for 4 miles 2,900 feet, at $1,200 per mile	5,520
	6,720
Add 10 per cent. for contingencies	672
Total	7,392

At present no improvement is required below Boudro's Canal, as it is probable that all vessels, from both below and above, on Little Caillou will go through the Lacache Canal into Bayou Terrebonne.

Drainage into the bayou should be prevented for the same reasons as given in the report on Grand Caillou.

Further information will be found on the accompanying chart.

Very respectfully, your obedient servant,

H. S. DOUGLAS,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

M 22.

SURVEY OF PASS MANCHAC AND BAYOU MANCHAC, LOUISIANA, FROM ITS MOUTH TO THE MISSISSIPPI RIVER.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 27, 1882.

GENERAL: I have the honor to submit the following report of Assistant Engineer J. C. Buchanan on the survey of Pass Manchac and Bayou Manchac, Louisiana, from its mouth to the Mississippi River.

From the report of Mr. Buchanan it will be seen that the lower part of the Manchac from its junction with the Amite to Lake Maurepas, which is generally called Amite River, can be cleaned out for about $2,718.75; and from the junction of the Amite to a place called Bobbins for about $731.25; the total being $3,450. Above Bobbins low-water navigation could not be obtained except at a great cost, altogether incommensurate with the benefits to be obtained unless the Manchac were connected with the Mississippi by locks, which would be a work of very considerable magnitude, and which does not seem to be contemplated in the act of Congress directing the survey.

The survey, however, was made in sufficient detail to permit the making of approximate estimates if they should be needed. The bar at the mouth of the bayou, and Pass Manchac with its bars, appear to have sufficient water for navigation.

This report is accompanied by a tracing of the chart of Bayou Manchac in two sheets; a profile of the bayou, and a tracing of the chart of South Pass Manchac.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

Brig. Gen. H. C. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. JOHN C. BUCHANAN, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *January* 18, 1882.

SIR: I have the honor to submit herewith my report of survey of Bayou Manchac from its head to Lake Maurepas; survey of the bar at the mouth, in Lake Maurepas; survey of bar in Lake Maurepas, head of Pass Manchac; survey of Pass Manchac and bar in Lake Pontchartrain.

BAYOU MANCHAC.

Under instructions from Maj. C. W. Howell, Corps of Engineers, U. S. A., I left New Orleans on the 11th of February, 1881, and proceeded to the head of Bayou Manchac, in East Baton Rouge Parish, Louisiana. The survey was begun on the 17th of February, * * * starting the levels from bench-mark No. 26 of the Mississippi River Commission Survey.

* * * * * * *

At the head of Bayou Manchac, 556 feet down the bayou, there is an earth dam thrown across the bayou, the dimensions of which are 19 by 110 feet on top, 69 feet at the base, and 8.4 feet deep. I understood that the legislature of Louisiana granted permission to the citizens to place this dam there in 1828. The course of the bayou from the Mississippi River is in an easterly direction, and for 7.5 miles to J. T. Bobbins' place has a width of from 60 to 110 feet, and in many places has little or no water in it, and is much grown up with small timber, and many trees have fallen into it. The banks are from 9 to 13 feet from top to the bottom of bayou. The fall from the head of the bayou to Bobbins is 23.527 feet. This portion of the bayou goes dry in the dry season. I estimate that the bayou can be cleaned out from its head to this point (7.5 miles) for $450 per mile = $3,375, but it would be useless for navigation during low-water in the Mississippi River unless it were excavated to a greater depth. This would necessitate the building of locks at its head, as high-water in the Amite River overflows the Manchac nearly to Bobbins. This with the Mississippi River water flowing through the Manchac would inundate a large area of country. On the 19th of February the water in the Mississippi River was 1.23 feet lower than the head of the bayou. The country adjacent to the bayou, for a portion of the distance to Bobbins, is very fertile. I estimate that Bayou Manchac can be cleaned out from the Amite River to Bobbins, 11.25 miles, at $65 per mile = $731.25. This would not give navigation throughout the year, as in dry seasons it goes nearly dry above Alligator Bayou, 8.4 miles from its head, and for a portion of the year boats might not be able to go as far as Alligator Bayou. The fall to Alligator Bayou is 25.88 feet. The present head of navigation is to Wood's Creek, 11.1 miles from the head of bayou. A steam launch would go a little farther up, to Foreman's Landing, 9.5 miles from the head of bayou, and tow down flat-boats loaded with sugar, &c.

At Hope Villa, 11.9 miles from the head of bayou, the fall is 32.09 feet, and at the bar at the junction of the Amite River, 18¾ miles from the head of bayou, the fall is 29.18 feet. At the time of the survey there was 9.5 feet of water on the bar at the junction of the Amite, but I was told that at times there was as little as 4 feet; the bar is of sand.

The steamer Alice makes quite regular trips to Hope Villa, her draught being about 6 feet. The height of the banks above the bottom of the bayou, from the junction to Alligator Bayou, is from 13 to 25 feet.

There are very few snags or overhanging trees from the junction to Hope Villa.

An azimuth line was run from the head of the bayou to the junction of the Amite River. * * * The levels were run from the head of bayou to the junction of the Amite, and cross-sections taken about every half mile. Bench-marks were established in the vicinity of each cross-section. A chart and profile accompany this report. The levels are referred to bench-mark No. 26, Mississippi River Commission Survey.

During the time of the survey the water was quite high, and should it be the intention of the government to clean out the bayou it would be well for the bidders of the work to inform themselves regarding snags and trees fallen in the bayou at a lower stage of water than when the survey was made. * * * An examination was made of the bayou from the junction of the Amite River to Lake Maurepas.

* * * * * * *

The distance from the head of the bayou to its mouth in Lake Maurepas is 57.25 miles. There are only 36¼ miles from Lake Maurepas to the junction of the Amite which require cleaning out. I estimate that this can be done for $75 per mile = $2,718.75.

The timber and saw-mill business are the principal industries on this portion of the bayou. This part of the bayou has a width of about 190 feet, and from 11 to 50 feet depth.

The survey of the bar at the mouth of the bayou, in Lake Maurepas, shows it to be of mud, with some sand and fine particles of clam-shells, and has a depth of 6¼ feet of water at average low-water. A chart of the bar and bayou to the junction of the Amite River accompany this report.

PASS MANCHAC.

A base line was measured along the west rail of the railroad bridge across Pass Manchac. * * * Stations were established, and a survey of the bar at the head of Pass Manchac made. * * * This bar is of mud, sand, and particles of shells, and has 7½ feet of water on it at average low-water. * * * The distance from the railroad bridge to the mouth of the pass is 6.7 miles. * * * There is a depth of water in the pass from 17 to 49 feet, and a general width of 800 feet.

Survey of bar at mouth of pass, in Lake Pontchartrain, shows it to consist of mud, sand, and particles of shell, and there are two channels, having 7¼ and 8 feet of water in them at average low-water. The deepest of these channels is the more difficult to navigate, owing to its close proximity to cypress snags, &c. A chart of Pass Manchac and bars at head and mouth of pass accompany this report.

* * * * * * *

Respectfully,

JOHN C. BUCHANAN,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

M 23.

SURVEY OF BAYOU PLAQUEMINE, LOUISIANA.

The survey was made in connection with the survey of the Atchafalaya, which commenced at a point 3 miles below the head of that river, and was connected with it through Grand River or Bayou. The line of levels that was run down the Atchafalaya, and which was connected with the Mississippi River Commission's bench-mark at the mouth of Red River, was continued up the Plaquemine from its junction with

Grand Bayou to its head where another connection with the bench-marks of the Commission furnished a test of the accuracy with which the levels had been run on the present survey. The length of line over which the connection between the Commission's bench-mark was made was 107 miles nearly, and the discrepancy in connection was 0′.755. Bench-marks were established at short intervals, and the elevation of the water surface in the bayou taken frequently. Bearings were taken on true azimuth and distances determined by stadia readings. Bayou Plaquemine, which extends from the Mississippi River to Grand River or Bayou, is 11 miles long, and was formerly an overflow coulée of the Mississippi River, but after the failure of an attempt to secure a passage between the two that would serve the purposes of navigation during low as well as high water in the Mississippi, the connection that had existed was closed entirely by a levee that was completed in 1867. After the high water of 1874, this levee was rebuilt further down the bayou and its height increased; its distance from the Mississippi at low-water is 1,400 feet; about 600 feet down the bayou from the new levee is the crossing of the Texas Pacific Railroad.

Above the mouth of Bayou Jacob, which is 5 miles from the Mississippi, Bayou Plaquemine is very much obstructed by cypress stumps in the bed of the stream and on its banks. The heavy timber that formerly grew in the stream was cut down to low-water level, when the attempt to open navigation into the Mississippi was made; and the stumps still remain, although rotted to such an extent that they can readily be removed.

From Darden's Bend to Grand River the obstructions that exist are due to the refuse from saw-mills that has been thrown in the bayou, narrowing the channel and shoaling it. Near the head of the ninth mile Bayou Gross Tête enters from the north, and from this point to Grand River the Plaquemine is wide and deep.

First mile.—From the new levee to the end of the mile, deep water (10 to 14 feet) is found in pools worn out by the current before the head of the bayou was closed. These pools are connected by shallow reaches that become dry or nearly so at extreme low-water.

Second mile.—The width between high banks in the narrowest places is about 180 feet. A bar formed by a drainage ditch is found near the middle of this mile, and above this point the channel is much obstructed by the refuse from two old saw-mills. Depth in shoalest place, 3 feet.

Third mile.—The width between high banks is about 200 feet. The obstructions, outside of those formed by stumps, are the shoals at Devil's Elbow and at the mouth of a drainage ditch which enters from the south, where only about 2 feet was found at time of survey. In low-water these places are dry.

Fourth mile.—The width of water surface is about 120 feet, and the depth of water varies from 4 to 9 feet.

Fifth mile.—At the lower end of this mile Bayou Jacob joins the Plaquemine. This was formerly the main bayou, as is shown by the fact that it is deep and free from stumps, &c., while the Plaquemine, as already stated, is much obstructed above the junction.

Sixth mile.—At the upper end of this mile is Darden's Bend, where the bayou widens out to 500 to 600 feet between the high banks. The water surface, at time of survey, was 360 feet wide, and the depth from 3 to 4 feet. In very low water this section is dry according to the statement of Mr. Darden. At other points along this mile the depth is about 20 feet, and at its lower end the low water channel is reduced in width to 120 feet by a shoal formed of sunken logs and refuse from an old saw-mill.

At the upper end of the seventh mile the channel is narrow and shoal, owing to accumulation of sunken saw-logs, bark, slats, sawdust, &c., the refuse from an old saw-mill. From this point to Indian Bend, lower end of eighth mile, the width of the bayou is about 170 feet and depth from 16 to 24 feet.

At Indian Bend the depth decreases to 13 feet.

The Gross Tête enters at the upper end of the ninth mile, and from here to Grand Bayou the bayou is from 240 to 280 feet wide, and the depth about 32 feet, with the exception of one place near the upper end of the tenth mile, where there is a shoal place 55 feet wide with only 12 feet of water on it. This is supposed to be an old wreck.

The plantation at Indian Bend is the last one on the bayou under cultivation. Formerly this whole section was taken up with sugar plantations, but with the removal of the raft in the Atchafalaya, the high water surface was raised, and now when the Mississippi River is high this country is overflowed. At first, as the removal of the raft progressed, the levees were raised, to guard against the increased height of water, but this course eventually became too expensive, as the volume of water passing from the Mississippi into the Atchafalaya increased so rapidly, until finally the occupancy of the land was given up entirely, and now during floods the old levees are frequently several feet under water.

In the table of levels appended, the datum plane is the same as that used at the commencement of the Atchafalaya survey, and to reduce the same to the plane of the Mississippi River Commission's levels a constant (6.256) feet should be supplied to all the elevations in the table.

The chart which accompanies this report gives the actual depths of water found at the time of survey and the location of bench-marks, &c.

Table of levels.

Date.	Number of bench-marks.	Reference of bench-marks.	Reference of water surface.	Description of bench-marks.
December 14	305	8.645	0.850	
14	306	8.943	0.865	A nail in cottonwood tree.
14	307	8.260	0.879	A nail in oak tree.
14	308	8.856	....	A nail in cottonwood tree.
14	309	9.108	....	A nail in pecan tree.
14	310	7.991	....	A nail in hackberry tree.
14	311	8.224	0.925	A nail in cottonwood tree.
15	312	11.190	....	A nail in locust tree.
15	313	14.112	0.848	
15	314	11.879	....	A nail in cottonwood tree.
15	315	13.748	0.870	Do.
15	316	13.465	0.871	A nail in pecan tree.
16	317	13.809	....	A nail in live-oak tree.
16	318	17.276	0.806	A nail in china tree.
17	319	17.871	....	A nail in locust tree.
17	320	17.033	0.862	A nail in pecan tree.
17	321	17.612	....	A nail in locust tree.
17	322	19.156	....	A nail in sweet-gum tree.
17	323	22.496	....	A nail in sycamore tree.
17	324	22.531	....	A nail in locust tree.
17	325	23.807	0.933	A nail in cottonwood tree.
17	326	20.293	....	Do.
17	327	21.968	....	
17	328	27.370	0.963	
17	329	25.710	....	A nail in oak tree.

M 24.

EXAMINATION OF BAYOU FUSILIER, LOUISIANA.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., May 18, 1882.

GENERAL: I have the honor to submit the following report of Assistant Engineer H. C. Collins, on the examination of Bayou Fusilier, Louisiana. The views of Mr. Collins are concurred in. A tracing of the chart is transmitted herewith.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. H. C. COLLINS, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *May* 15, 1882.

SIR: The examination of Bayou Fusilier was made June 10, 1881, and a report was made soon after, when the chart was finished, but by some means the report has been lost.

The whole length of the bayou, from its head in Bayou Barbeaux to the Teche, is but 4 miles. The bayou is a small stream with a width of but 45 feet at the top of the nearly vertical banks which bound the stream at low-water. This low-water channel runs by a very crooked route through a very direct high-water channel about 200 feet between its banks. Many cypress trees are growing in the channel, and its bends are so sharp that a boat wider than 15 feet or longer than 40 feet could not pass when the water was within its banks. The water of Bayou Barbeaux runs down the Vermillion River at any time when the water in that channel is lower than it is in the Teche, and the Fusilier is but part of the Vermillion, with which it forms an outlet of the Mississippi, by way of the Atchafalaya, Courtableau, and Teche, and is now the most western outlet of the valley. By making a dam at the head of the Vermillion to turn all the water of the Barbeaux to the Teche, water enough will be thrown into the Teche for supply of locks at low-water. The dam should be made only as high as the low-waterbanks, so that in the great overflows of the valley the Vermillion will yet act as an outlet for some of the water coming into the Upper Teche.

The bottom land forming the high-water channel is covered with a very thick growth of large trees.

The Vermillion, so far as it is a navigable stream, is but a tide bayou, and does not in the least depend on any fresh water for its navigation, so no harm could be done to it by using all the low-water discharge to improve the navigation of the Teche. For any other purpose the Fusilier is useless to navigation, and its channel needs no clearing out to make it available as a feeder to the Teche.

Yours, respectfully,

H. C. COLLINS,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

APPENDIX N.

IMPROVEMENT OF SABINE PASS AND BLUE BUCK BAR, AND OF THE SABINE AND NECHES RIVERS, TEXAS.

REPORT OF CAPTAIN WILLIAM H. HEUER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Sabine Pass and Blue Buck Bar, Texas.
2. Sabine River, Texas.
3. Neches River, Texas.

EXAMINATIONS AND SURVEYS.

4. Sabine Pass, Texas, through Sabine Lake and River to Orange and Sabine Lake, and the Neches to Beaumont, to ascertain the practicability and cost of a deep-water channel from Sabine Pass to Orange and Beaumont.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., August 14, 1882.

GENERAL: I have the honor to forward herewith my annual reports of the river and harbor improvements under my charge for the fiscal year ending June 30, 1882.

Very respectfully, your obedient servant,

W. H. HEUER,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

N 1.

IMPROVEMENT OF SABINE RIVER, TEXAS.

The bar at Sabine Pass was first surveyed in 1853, and a depth of 6 to 7 feet of water was found. It was resurveyed in 1873 and a project was made for dredging a channel across the bar to be of sufficient width for navigable purposes and from 12 to 15 feet in depth. This was completed in 1878, but the cut partially refilled and dredging was resumed in 1880, but was found expensive, and the dredged channel could not be maintained. In 1881 a resurvey was made, showing the former channels nearly obliterated, and a new project was made for obtaining a channel over the bar by means of jetties estimated to cost $3,177,606.50. This project was referred to a Board of Engineers, and their report was sent to Congress through the proper channels and was printed as Executive Document No. 147, on March 29, 1882.

The dredge-boat Essayons, which had done most of the dredging at this work, was about used up and no longer suitable for work here or elsewhere, and was therefore recently advertised and sold at public auction.

With the funds left over from former appropriations and those made by act of Congress of August 2, 1882, there is now available $301,296.12 for commencing work on the new project. It is thought that this will be nearly or perhaps quite sufficient to place in position the foundation course of the first or west jetty, which is 18,120 feet in length, or nearly 3½ miles. It is recommended to do the work by contract.

The following are the appropriations and allotments thus far made on Sabine Pass:

1852, survey	$5,000
1872, allotment for survey	2,000
1875	20,000
1876	38,000
1878	30,000
1879	25,000
1880	50,000
1881	150,000
1882, August 2	150,000
Total	470,000

Money statement.

July 1, 1881, amount available	$159,976 12
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	8,680 06
July 1, 1882, amount available	151,296 06
Amount appropriated by act passed August 2, 1882	150,000 00
Amount available for fiscal year ending June 30, 1883	301,296 06
Amount (estimated) required for completion of existing project	2,876,310 44
Amount that can be profitably expended in fiscal year ending June 30, 1884	500,000 00

COMMERCIAL STATISTICS.

In 1872 it was reported that the value of domestic exports from Sabine Pass was $1,505,731.

In the year ending June 30, 1881, the total tonnage passing over the bar was reported at 4,659 tons, and the value of exports and imports was estimated at $89,510.

A railroad is now nearly completed to Sabine Pass and trains are expected to run there within 60 days. Several other railways are projected to terminate at Sabine Pass.

The work is in the collection district of Galveston, Texas, about 60 miles distant, and the nearest light-house is at Sabine Pass. It is estimated that $500,000 can profitably be expended in continuing the work of building jetties during the fiscal year ending June 30, 1884.

N 2.

IMPROVEMENT OF SABINE RIVER, TEXAS.

This work was in charge of Capt. C. E. L. B. Davis, United States Engineers, until October 23, 1881, when it was transferred to me.

The original depth of water at the mouth of this river on its bar was 3½ feet.

The project for improvement made in 1871 and modified in 1873 was to deepen the water at the mouth of the river to admit vessels drawing 5 feet of water and to accommodate the commerce of the region through which the river runs.

In 1878 Congress made an appropriation of $10,000 for improving the river, and in 1879, $6,000 more was appropriated for the same purpose; in 1880 another amount of $5,000 was appropriated, and in 1881, $7,000 was added to continue the improvement.

Up to June 30, 1881, with the funds available a channel was dredged over and through the bar at the mouth of the river, having a least depth of 6 feet of water in it and varying from 70 to 100 feet in width, and contracts were made for cutting away trees on the banks of the Narrows, removing snags, and making cut-offs in the Narrows.

PROGRESS MADE DURING YEAR ENDING JUNE 30, 1882.

Mr. Hyatt's contract was completed in November, 1881, for which he received $5,950. He made a cut-off from the main river into the Narrows 315 feet in length, varying from 60 to 75 feet in width, and having a depth of 5 feet of water in it; the bottom was of quicksand. About 165 cubic yards of earth were removed from the upper side of this channel to aid descending boats in turning into the cut.

At Dead Bend, in the Narrows, a short cut-off was made about 70 feet in width and having a depth of 7 feet of water at ordinary low-tide, and all sunken logs and snags were cut off or removed in the upper 4½ miles of the Narrows. The improvements thus far made enable vessels drawing not over 5 feet of water to reach the head of the Narrows, about 30 miles above the town of Orange, at such times as there is this depth of water in the river. This leaves about 60 miles of river above the head of the Narrows yet to be improved, which may enable small steamboats to get up to Belgrade with a little less danger than at present during such times as there is any navigable water in the river.

Major Mansfield estimated this 60 miles of river improvement to cost about $5,000. From the best information I could get, while recently in this vicinity, I was informed that whenever boats (meaning steamboats) could get through the Narrows, they could get up to Belgrade, but that at present there was not water enough in the river to float a skiff from Belgrade to Orange. At Belgrade the river is reported to be 150 feet wide, and the place is said to contain one family, who keep a small store. There are a few settlements on the river above Belgrade, but the largest of them has a population (it is reported) of over thirty persons. During high-water (flood in the river) steamboats make a few trips to East Hamilton, where the water sometimes rises to a height of 25 feet, and bring down such cotton as can be had. In 1878, 1,800 bales were thus transported by river, but most of it goes overland to Shreveport, La. The principal interest on the river is that of log cutting, and the logs are floated or rafted to Orange, Tex., where there are some fine saw-mills. The log-men desire that a dam be built across the head of Old River, at junction of Old River with the Narrows, as they claim that many of their logs are lost by floating into Old River, where a raft is formed and is impassable, instead of into the Narrows. It is very questionable if government is justified in damming a river for the sake of saving a few hundred logs, particularly when the construction of such a dam must throw an immense volume of water through the Narrows during floods, and probably cause banks to cave and trees to fall, thus causing new obstructions to such channel as can be navigated for possibly one-half of the year. Some idea of the uncertainty and cost of improving this river may be had from the fact that in 1856 the State of Texas appropriated over $50,000, and in 1874 a large amount of State land, for the improvement of the river. Snags were cut out and removed, and timber near the banks was deadened, but no useful results remain.

In July, 1881, a contract was made with General J. E. Slaughter, to dredge the bar at the mouth of the river with a view to make the channel there as wide and deep as the funds available—about $12,000—would permit. The contract was for 37 cents per cubic yard. The completed cut will not be over 6 feet in depth and as wide as can be made for this money. Work on this contract has not yet commenced, but the contractor was directed to begin his work not later than September 1, 1882.

PROBABLE OPERATIONS FOR THE YEAR ENDING JUNE 30, 1883.

To dredge at the mouth of the river as far as funds will permit, and in case it becomes necessary to remove any falling trees in the Narrows, to do so; and when the channel at mouth of river is completed to mark it with stakes or piles so that vessels may know where the channel is.

The following are the amounts thus far appropriated for this river:

1878	$10,000
1879, March 3	6,000
1880, June 14	5,000
1881, March 3	7,000
1882, August 2	4,000
	32,000

ORIGINAL ESTIMATES.

Work at mouth (report of 1871)	$38,000
Removing snags, &c. (report of 1873)	18,000
Work on the Narrows (report of 1880)	17,500

This work is not susceptible of permanent improvement, and with the funds now available it is thought that the river can be improved sufficiently to accommodate all vessels using it for several years to come; hence no appropriation is recommended for the year ending June 30, 1884.

The work is located in the collection district of Galveston. The nearest light-house is at Sabine Pass.

Three or four steamboats run on the river when there is business or water for them, and several small sailing vessels run below Orange, aggregating perhaps 1,500 tons. The mills at Orange can cut all the logs they get, and more; in 1881 it is reported that 30,000,000 feet B.M. was shipped. Since then, perhaps the largest portion now leaves there by rail, as the railway is completed from Texas to New Orleans.

Money statement.

July 1, 1881, amount available	$17,935 84
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	6,130 75
July 1, 1882, amount available	11,805 09
Amount appropriated by act passed August 2, 1882	4,000 00
Amount available for fiscal year ending June 30, 1883	15,805 09

N 3.

IMPROVEMENT OF NECHES RIVER, TEXAS.

This river was surveyed in 1872–'73, and resurveyed from Bevilport to its mouth in 1880.

When work was commenced on the river, the bar at the mouth had but 2½ feet water on it; a channel was dredged through the bar, having 5 feet of water in it, and varying in width from 30 to 60 feet; the narrow cut (30 feet width) was short, only about 1,200 feet in length. In the fiscal year ending June 30, 1882, the river was improved between Yellow Bluff and Bevilport by cutting away certain overhanging trees from the banks, cutting out sunken snags and logs, &c. This work was done by contract awarded to Neyland & Henderson, at a cost of $7,465.50. The river is now, therefore, navigable during high-water stages, say three months in the year, to Bevilport, and at low-water stage to Weiss Bluff, where one small steamboat runs with some pretensions to regularity.

With the appropriation made August 2, 1882, $5,000, it is possible that a contract may be made for widening the narrow portion of the channel on the bar at the mouth of the river, and for driving a line of stake piles along one edge of the channel.

The following are the appropriations thus far made for improving this river:

June 3, 1878	$8,000
March 3, 1879	5,000
June 14, 1880	5,000
March 3, 1881	3,000
August 2, 1882	5,000
Total	26,000

The work is located in the collection district of Galveston. The nearest light-house is at Sabine Pass.

Money statement.

July 1, 1881, amount available	$8,007 56
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	7,726 12
July 1, 1882, amount available	281 44
Amount appropriated by act passed August 2, 1882	5,000 00
Amount available for fiscal year ending June 30, 1883	5,281 44

COMMERCIAL STATISTICS.

It has been estimated that 10,000 bales cotton could be raised on this river; the amount *actually* raised and shipped is not known. The principal business is floating logs to Beaumont; about 2,000,000 feet per month are now floated. The Sabine Pass and East Texas Railroad now runs close to the Neches River, and is nearly completed to a point above the head of navigation on this river; so that when there is no water in the river for steamboats to run, cotton producers can ship their product by rail.

Small appropriations may be occasionally necessary to do some dredging to the bar at the mouth of the river.

N 4.

EXAMINATION OF SABINE PASS, TEXAS, THROUGH SABINE LAKE AND RIVER TO ORANGE, AND SABINE LAKE AND THE NECHES RIVER TO BEAUMONT, TO ASCERTAIN THE COST AND PRACTICABILITY OF A DEEP WATER CHANNEL FROM SABINE PASS TO ORANGE AND BEAUMONT.

OFFICE UNITED STATES ENGINEERS,
New Orleans, La., January 11, 1882.

GENERAL: The river and harbor act of March 3, 1881, provides for an examination or survey of "Sabine Pass, Texas, through Sabine Lake and River to Orange, and Sabine Lake and the Neches River to Beaumont, to ascertain the cost and practicability of a deep-water channel from Sabine Pass to Orange and Beaumont."

From a personal examination of a considerable portion of the waters herein referred to, viz, Sabine Pass through the Lake and Neches River to Beaumont, from the study of the survey charts of Sabine River, and from information from persons navigating Sabine Lake (which lake, I believe, has never been surveyed), I am enabled to submit the following report:

The Sabine Pass is a body of water about 1,800 feet wide in its narrowest part, about 6 miles in length, and having a depth of water through it varying from 6 to 40 feet. It forms a part of the boundary between the States of Louisiana and Texas, and connects the waters of the Gulf of Mexico with those of Sabine Lake. In approaching Sabine Pass from the Gulf we find a soft mud bar, whose distance across, measured from 18 feet depth outside to the same depth inside, is a little over 4 miles, and whose crest, which is about 2 miles across, has a very nearly uniform depth of 6 feet of water upon it.

Once over the bar, the channel begins to deepen, and maintains a good navigable depth of about 18 feet (except over one small reef of shell, about 200 feet across it, over which there is about 12 feet of depth) until the head of Sabine Pass is reached. Directly opposite the small town of Sabine Pass the channel is over 30 feet in depth. Above the town the pass begins to widen and shoal somewhat until an obstruction called Blue Buck Bar is reached, which is between 4 and 5 miles above the town. This bar is of mud and shells; has a channel through it 5½ feet in depth, and about 2,000 feet in width, and of which the length is about 1¾ miles. When this bar is crossed we are in what is known as Sabine Lake, which has a depth of water in it varying from 6½ to 8 feet. The lake is about 15 miles in length and about 8 miles in width. The deepest water, about 8 feet, is found near the eastern shore. Small vessels navigating the lake, however, generally go for Blue Buck Bar, toward the head of the lake, directly toward the mouth of the Sabine or Neches rivers. On either of these lines the depth of water is nearly uniform, and varies from 6½ to 7½ feet. The Neches River has two mouths and the Sabine River three. These rivers are only about 3 miles apart, and at the mouth of each of them is found a bar composed of fine sand and mud, sediment brought down by the rivers, and having a channel through them about a mile in length. The Sabine River Bar has a channel through it 6 feet in depth, and from 70 to 100 feet in width. From this bar to the town of Orange, about 12 miles distant, the least depth of water in the river is 18 feet.

The Neches Bar has had a channel dredged through it 5 feet in depth, whose least width was 30 feet, and of which the average width was 60 feet. From the bar to the town of Beaumont, about 28 miles distant, the least depth of water in the river is 16 feet.

Two small steamboats run on the Neches River between Sabine Pass and Beaumont, one of which is supposed to make weekly trips; the other makes an occasional trip.

The Sabine River is used by small sailing vessels, drawing 5 to 6 feet of water, and engaged in the lumber business.

Beaumont and Orange are two small but flourishing towns, engaged principally in the lumber business; and the railroad running from New Orleans to Texas passes through both places.

We come now to the practicability of getting a "deep-water channel" from Sabine Pass to Beaumont and Orange.

At present there is a channel 5 feet deep between these places.

To get a 6-foot channel, we should have to cut through Blue Buck Bar, Sabine River Bar, and Neches River Bar, an aggregate length of about 4½ miles; estimating the channel at 100 feet in width, would require the removal of about 70,000 cubic yards of material, which, at 30 cents per yard, would cost	$21,000
A channel 7 feet deep would cost, approximately	42,000
A channel 8 feet deep would have to be cut into the lake, and across its entire length, 1 foot depth; therefore an 8-foot channel would require about 499,046 cubic yards dredging, at 30 cents, or	149.713
A 10-foot channel would cost—1,259,348 cubic yards, at 30 cents	377,804
A 16-foot channel would cost, approximately—4,500,000 cubic yards, at 30 cents	1,350,00

For every foot in depth beyond 7 feet, a channel must be cut at least 18 miles in length.

It seems useless to carry the calculation and estimate further. The present depth of 5 feet of water is more than sufficient for all the requirements of commerce of this locality for many years to come. There is no interest worth mentioning at either Beaumont or Orange other than that of the lumber trade, and the mills at both places cannot be kept busy all the year round on account of the difficulty of getting logs; and this difficulty is not due to any lack of water *below* Beaumont or Orange. Until the bar at the outer end of Sabine Pass is improved, which will require at least two, and possibly four years of work, and will probably cost at least $2,000,000, it seems useless to try to get a deeper channel to Beaumont or Orange. Any vessel which can now get into Sabine Lake can get to Beaumont or Orange.

Respectfully submitted.

W. H. HEUER,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

SURVEY OF ENTRANCE TO SABINE PASS, TEXAS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 27, 1882.

SIR: I have the honor to submit herewith a copy of a report to this office from Capt. W. H. Heuer, Corps of Engineers, of the results of a survey of the entrance to Sabine Pass, Texas, made with the view of a reconsideration of the plan of improvement, together with a copy of a report from the Board of Engineers for Fortifications and for River and Harbor Improvements, to which Captain Heuer's report was referred for examination.

For the purpose of securing deeper water over the bar at this place it was determined in 1877 to confine the improvement to dredging a channel of a width only sufficient for the needs of commerce and 12 feet deep. This, however, has proved very expensive, owing to the locality being exposed and distant from supplies, and insufficient because the material forming the bottom of the channel is such as to require constant dredging to prevent filling up, and has led to the consideration of measures for the preservation of a channel, among others by jetties, with the view of contracting the width of the entrance so as to induce scour. In the reports herewith submitted the subject is treated so fully that I beg leave to suggest they be transmitted to the House of Representatives for the information of the Committee on Commerce.

Very respectfully, your obedient servant,

H. G. WRIGHT,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

Hon. ROBERT T. LINCOLN,
Secretary of War.

REPORT OF CAPT. W. H. HEUER, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEERS,
New Orleans, La., January 28, 1882.

GENERAL: I have the honor to forward in a separate package by mail this day a report, project, and estimate on Sabine Pass, Texas. The maps will be forwarded by express on the 30th January, 1882.

As the estimated cost of the work exceeds $3,000,000, I have to request that the report be referred to a Board of Engineers for consideration, report, and advice.

Very respectfully, your obedient servant,

W. H. HEUER,
Captain Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 28, 1882.

What is known as Sabine Pass is a body of water a little more than 7 miles in length, varying in width from one-third to 1½ miles, and, with the exception of about 900 feet in length in the aggregate, has a channel through it carrying a least depth of 18 feet of water, whose average width is about 500 feet. This channel in places has depths as great as 39 feet. The 900 feet exceptional length above referred to contains depths varying from 12 to 17 feet, lies on a shell reef which can be easily and economically dredged through.

The pass forms a portion of the boundary between the States of Louisiana and Texas, and connects the waters of the Gulf of Mexico with those of Sabine Lake, into which the Neches and Sabine rivers, each having numerous small tributaries, flow.

As we approach the southern or Gulf end of the pass, we find the banks much farther apart than they are higher up, thus forming a funnel or bell-shaped mouth, beyond which there is a large soft mud bar having a tolerably uniform depth of a little less than 7 feet of water on its crest, and of which the shortest distance across measured between the 18-foot curves is 18,470 feet, or about 3½ miles. The inner slope of the bar from the 7 to the 18 foot curves of depth is 8,000 feet, or about 1 on 727 feet; the outer slope is also about 1 on 727 feet.

On both sides of the pass, and extending for many miles, the country is nearly flat, the average elevation of its surface being less than 2 feet above the level of mean low-water. In 1873 Major Howell, in running a line from Galveston to Sabine Pass for a canal, reports the highest land met with at about 5 feet high, one-half a mile in width, and situated about 4 miles to the westward of Sabine Pass.

The shore line, along the coast, extending from 10 miles to the westward and nearly 200 miles to the eastward of Sabine Pass, is a marshy alluvion, and forms very nearly an arc of a circle whose center is situated in the Gulf of Mexico, distant about 150 geographical miles. The 18-foot curve of depth runs nearly parallel to and is about 3 miles distant from the shore line, while the 10-fathom curve is nearly 40 miles out in the Gulf.

In 1873 a survey was made of Sabine Pass Bar under the direction of Major Howell, by Lieut. H. M. Adams, who reported 6½ feet of water on it. In 1877 and 1878 another survey was made of the bar and extending through the pass, under Major Howell's direction; and the survey just completed under my direction shows that since 1873 no material changes have occurred, except that where narrow channels were dredged through the bar, particularly on the crest and outer slope, they failed to maintain themselves.

A condensed history of the work for the improvement of Sabine Pass and its bar is about as follows: In 1853 Lieut. Henry L. Smith made an examination and partial survey, and estimated for a dredged channel cut to 9 feet depth at a cost of $7,000, and finally says that "nothing seems necessary to be done to improve the bar at the entrance of this harbor." See page 925, Chief Engineer's Report, volume 1, 1875.

In 1873, Lieutenant Adams, in his report, says:

> No improvement seems to be required on the Sabine (Pass) Bar. The vessels now in the Sabine trade have no trouble in crossing the bar at ordinary low water.

In 1875 Major Howell reported a plan and estimate for dredging a channel across the bar (page 946, volume 1, 1875, Chief of Engineer's Report; also page 902, report for 1879).

Congress appropriated $20,000 for this work. The work was let by contract. The contractors took out about 33,000 cubic yards of soft material by dredging, and then threw up their contract. In 1876 Congress appropriated $38,000 additional for the work, proposals were invited, but as the lowest bid would not complete a channel 12 feet deep over the bar all bids were rejected. The United States dredge-boat Essayons went there and about half completed a channel 12 to 15 feet deep, when her boilers failed. In January, 1878, the dredge-boat McAllister, with all on board, was lost in attempting to go to Sabine Pass from the Mississippi River. In 1878 the Essayons resumed work and obtained a channel 12 feet deep, 75 feet in its least width, and about 18,000 feet in length. She was then taken away for repairs. In 1878 $30,000 was appropriated. In 1879 $25,000 was appropriated, and in 1880, $50,000 more was appropriated. In September, 1880, the Essayons again went to Sabine Pass and remained until August, 1881, having worked on the bar 482 hours during this time, when she was again sent away for repairs. In June, 1881, Captain Davis, United States Engineers, who had recently been assigned to the work, said in his report:

> I carefully sounded the bar from a small boat, running diagonally across the channel from side to side. On every crossing but three I found 12 feet or more, on the three crossings the soundings being 11.9, 11.9, and 11 feet, respectively, which, considering that up to that date no dredging had been done in over a month, was a better showing than I expected. Still, the deep water was narrow and difficult to find. The Coast Survey steamer Gedney, light-house steamer Geranium, and revenue cutter McLane, all report shoal water of late, about 5¼ feet, showing that the line of deep water must be very narrow and impracticable for purposes of navigation.

The survey just completed shows how little of the former dredged channel remains. It is so narrow and so nearly obliterated that in many places but one sounding could be obtained in crossing it.

The appropriations and allotments to the present time applicable to Sabine Pass have aggregated $320,000, of which about $167,000 has been expended, by far the greater portion in dredging and repairs to dredging machinery, and for which we have no practicable channel to show. There remains now, available for use on this work, in round numbers, $153,000.

The bar at Sabine Pass is composed of a sticky, soft, blackish-blue mud, known to be such by borings and probings made on January 2, 1882, to a depth of 30 feet below the water surface. The borings were made in various places on the bar, some on the crest, others on the inner and outer slopes. Gas pipes were pushed through the mud to depths of 30 feet and their contents examined. An iron rod, three-quarters of an inch square and 20 feet in length, pointed at its lower end, would of its own weight penetrate from 6 to 12 feet in the mud; two men, by pushing on it with a slight effort, could force it down its full length, and could push a 1½ inch gas pipe down 30 feet. The bar is probably a drift and wave bar, and is certainly not a delta bar, for the reason that the Sabine and Neches rivers, which carry considerable solid matter, drop this matter at or near their mouths, near the head of Sabine Lake, whose waters form a settling basin for this sediment, which is dropped about 25 miles above the Sabine Pass Bar. It is thought that the mud of which this bar is composed is eroded from the soft alluvial soil forming the coast for several hundred miles to the eastward, and is brought here by the wind waves and tidal currents. When the Essayons was cutting at the channel in 1881 it was reported that there were some clay ridges running across the channel and underlying the mud at a depth of about 16 feet below the water surface. As I could find none of these clay ridges, and as no borings had previously been made on or near the bar, inquiry developed the fact that the clay was supposed to be there on account of the difficulty which the Essayons had in cutting through it, and by the color which the suspended particles gave the water while being stirred up.

In searching for this clay on January 2, 1882, with a pole, in a small boat, I found numerous places where the bottom was hard or offered a slight resistance to the pole, but upon pushing through it again found the characteristic soft mud at a depth of 2 to 3 inches below the slightly indurated mud. The surveying party who carefully examined the locality of the former dredged channel, found great numbers of these hard patches, but never anything approaching clay in appearance or hardness. The care with which this examination was made can be judged from the numerous soundings in and near the old channel lines. The only sand found in the vicinity of Sabine Pass is a small strip 10 to 15 feet wide, which of late years has formed on Texas Point.

We are therefore almost justified in stating that the bar is composed of soft mud to a depth of 30 feet below the water surface, as no traces of clay, sand, nor shell were found.

The tidal current flowing out of Sabine Pass, after leaving there, owing to the long distance of the bar from the throat of the pass, spreads and loses so much of its velocity that it has not sufficient strength to scour much, if any, of this mud from the bar. The feeble current, the softness of the mud, the narrow dredged channel, its steep side slopes, and the pounding of the sea on the bar, and the currents across the channel instead of through it, are amply sufficient to explain the non-maintenance of the dredged channel.

An examination of the map shows the changes which have occurred in the shore lines of the outer portion of Sabine Pass within the last three years. Louisiana Point has in places washed away about 200 feet in distance, while Texas Point has made out about the same distance.

TIDES.

On the map is shown a diagram of the tides, reduced from the self-registering gauge, for the month of December, 1881. We find the mean rise and fall of the tides to be 1.4 feet, while the extremes between the highest and lowest water during the month were 4.4 feet.

The height and time of duration of the tides at this locality are very much influenced by the winds. On two occasions in November and December, 1881, the tide was running flood for twenty consecutive hours, and in nine instances it ran ebb for sixteen consecutive hours.

By tabulating all of the tides during November and December, 1881, we find that the average duration of the flood-tide was seven and three-tenths hours, while that of the ebb was nine and three-tenths hours.

This, unexplained, would indicate that the ebb was much more sluggish than the flood tide, when the contrary was known to be the fact from numerous current observations, and is due to the drainage water carried out on the ebb-tide. Owing to the contrary currents in the pass flowing out on the surface for over two hours when a current at a lower level was running in, it was almost impossible to gauge the volume of water passing through the pass in any tide with anything like accuracy. We found on the bar the mean rise and fall of the tides to be about 1.4 feet; at the town of Sabine Pass, the mean height of the tide was a little less, but over 1 foot in height. In the Sabine and Neches rivers, 50 miles from Sabine Pass, the tides are said to be felt, and yet at the mouth of both of these rivers, where the bars have been dredged, we have no records of the tidal range. For our purposes we can get a good idea of the volume of the tidal prism by considering Sabine Lake as our tidal reservoir.

The lake is about 15 miles long by 8 miles in width, covering an area of about 120 square miles. At the lower end of the lake the tide rises 1 foot. At the northern end of the lake we don't know what the tide is, so we shall call it 0. This gives a mean height of one-half foot over an area of 120 square miles, or a volume of 1,672,704,000 cubic feet, which flows in in seven and three-tenths hours and out in nine and three-tenths hours. This gives a flow during flood-tide of an average of 63,650 cubic feet per second, and during an ebb of 50,000 cubic feet per second.

The Neches and Sabine rivers drain an area of country embracing about 9,000 square miles, over which there is an average annual rainfall of upwards of 50 inches of rain. (The average for ten years at Galveston, only 60 miles distant, is 51.68 inches, and we know it to be more in the timbered country of these rivers.) Calling the rainfall 50 inches, and allowing one-half to be lost, we would then have 155,282 cubic feet of water per square mile per day which must flow out in 1½ ebb-tides, or say fourteen hours, or at an average rate of 27,727 cubic feet per second. This added to the 50,000 cubic feet per second mentioned above, gives the ebb-tide volume an average steady flow of 77,727 cubic feet per second. This flows through Sabine Pass. At two places in the pass where it is narrow—one opposite the upper end of the town and the other opposite the light-house—the two places being about 4 miles apart, careful cross-sections were made, and in these sections numerous current observations were made. The area of the upper or hotel section was 28,112 square feet, while that of the lower or light-house section was 27,376 square feet. A mean of the two would be 27,744 square feet. If, now, we assume that the tidal flow was regular and uniform, the rate per second of the flood-tide through this mean area would be 2.3 feet, while that of the ebb-tide would be 2.83 feet. Our observations in the two sections show current velocities on the ebb-tide varying from 0 to 4½ feet per second, which was the maximum observed. Current observations made on the crest of the bar in 1878 give the strongest ebb surface current at 1.7 feet per second; at a depth of 2 feet the velocity fell to nine-tenths of 1 foot, and at 4 feet depth (the water being but 6 feet deep on bar) the velocity was only one-half foot per second.

Of the flood currents observed on the bar, the greatest observed velocity was 1.1 feet per second.

From nearly two months' observations it was found that the flood-tide in its first quarter, and sometimes extending nearly through the second quarter, came in on the Louisiana side, gradually widening until, when running at its strongest, it seemed to concentrate from the Gulf toward the throat of the pass; the current would frequently run out on the Texas side for two hours after the tide had commenced to run in on the Louisiana side. The ebb-tides acted almost exactly opposite. The first of the ebb-current was always on the Texas side, then this thread began to widen and extend toward the Louisiana shore, until finally the entire current over the bar was an ebb-current. We also observed that after southerly winds, when the water was banked up in Sabine Lake and the Sabine and Neches rivers were high, there would be a surface current running out during an entire flood-tide, and that this water was fresh enough to drink.

Outside of Sabine Pass there is an undoubted littoral current whose general direction is from the east towards the west. This is variable, depending on the wind, and runs with a velocity of from 1 to 3 miles per hour. This current is appreciable for at least nine months in the year. During and after a strong southeaster this current pushes in toward the pass, mostly towards the Texas shore, but this is ordinarily of but two or three days' duration.

We now have the results of several surveys of Sabine Pass and its bar, know something of its tides and currents, have made sufficient borings to determine the character of the bar, and also know that there is a variable littoral current here, and have had the experience of at least two dredged channels across the bar. With this information, it is required to project a plan and make an estimate for the improvement of Sabine Pass and the bar at its mouth.

The dredged channels were not maintained; the conditions for self-maintenance were unfavorable, and were mentioned on pages 4–5 of this report. Dragging the channel with a large harrow attached to a steam-tug was tried, and the experiment showed that the channel could not be improved by this method. Would protecting works on either or both sides of the cut have maintained it? Possibly; but such works of themselves would have been of the nature of jetties, and they would probably have to extend the entire length of the cut. The problem to be solved at the time the cut was made was to get a channel through the bar. This was done in the quickest and cheapest manner, by dredging. It was not known whether the channel would be maintained or not. Had there been many steam vessels using the channel, the continuous cutting of the bottom and stirring of the mud might have helped to longer maintain the channel, but there was no commerce there for vessels of this class, hence no vessels worth mentioning. The few vessels (steam) that went there were on government business, drew less than 8 feet of water, did not know where the narrow cut was, and would, in consequence, get ashore, and do more damage than benefit to the cut. The experience gained from dredging here was valuable. It proved that a channel could be dredged, that it was expensive work, and that such channel, if let alone, would fill up again.

With this experience before us, to resume dredging now without some means of protecting the work done or to be done would be worse than a most serious error.

In the pass itself, where the pass is narrow (1,800 to 1,900 feet in width), we have good channels self-maintaining; the bottom of the entire pass, excepting here and there where a few small oyster reefs are scattered about, is of precisely the same nature; that is, soft, blackish blue mud, as that found on the bar. In these narrow gorges of the pass we find channels 25 feet deep and over 500 feet wide. Where the pass is much wider, we have, of course, the same volume of water, but less depth and a wider channel. That this depth, its production, and maintenance, is due principally to the velocity of the tidal flow, there is no doubt, and therefore, if similar conditions can be reproduced on the Sabine Pass Bar, there is no good reason why similar results should not be obtained there.

We can only hope to produce similar conditions by means of jetties. If we can concentrate a sufficient quantity of water on a limited portion of the bar, we get over that portion of the bar an increased current. This, if it produces a scour, makes and maintains the channel. The pass itself is sufficiently wide and deep, with its funnel-shaped mouth, to offer but little obstruction to the free movement of the flood-tide; the banks of the pass are the jetties which concentrate and confine the water through them, and the Sabine Lake is the reservoir into which the waters flow. If jetties be built, they must therefore be constructed in such a way as to offer the least resistance to an inflow of the tides, and yet control the outflow and direct it in a certain fixed direction.

Their distance apart, direction, length, height, cross-section, composition, and, finally, their cost, are matters of the greatest importance.

They should be far enough apart to secure them against serious subsidence that may occur from the excavation of a deep channel between them, and their direction should be such as to direct the current passing out between them with or across the littoral current, and certainly not against it. The nearer they be placed together with the same volume of water flowing between them, the deeper ought to be the channel which they should produce, and the consequent greater danger of their undercutting and final loss. In the pass, at its narrowest place (opposite hotel), the banks are 1,820 feet apart, and there we have depths of 39 feet. At the light-house the banks are 2,145 feet apart, and the greatest depth in this section is 27.7 feet, having a channel through it 500 feet in width, of 22 feet in depth. As the waters of the pass form an

18-foot deep channel, except over a few small oyster reefs mentioned, we ought to try to get 22 to 25 feet depth of channel over the bar. The mean of the areas of cross-sections at hotel and light-house is 27,744 square feet, the respective areas are 28,112 and 27,376 square feet, differing from the mean only 1.3 per cent., while their mean depths are respectively 15.4 and 12.7 feet, and this difference of mean depth is due to the difference of the widths of the two sections.

On the chart I have projected the lines of the jetties parallel to each other and 1,800 feet apart, with the following object in view: As there must be but little obstruction to the inflow of the tides, we must either build low (drowned) jetties or leave openings near the shore; but the same conditions which permit of easy inflow of the tides may permit the escape of so much of the ebb-tides as to destroy their scouring power. I therefore assume that the jetties to be built are high jetties, the inner portion of each jetty being drowned. We know that the flood-tides come in for two hours or more from the east or Louisiana shore before reaching the Texas side; therefore the east jetty should be a low one or else have a large opening near its shore end. The ebb-tides incline toward the Texas shore; therefore the west jetty should be a high one with a smaller opening near its shore end, to prevent as much as possible the escape of the ebb-tide.

If both jetties be built high with shore openings to permit the fullest inflow of flood-tides, we approximate more nearly to the condition of things in the pass. We have the funnel shape formed by the jetties and the shore lines, and we more certainly control the action of the ebb-currents than we could with low jetties; but the objection to high jetties is that they cost much more money to build and are more liable to injury by heavy seas than low jetties. Leaving out the question of difference of cost and maintenance of high and low jetties, let us see what we may expect with high jetties. We have already said that the mean area of the cross-sections in the pass was 27,744 square feet. If we leave openings near the shore ends of the jetties, protecting the openings by a sill (mattress) to prevent scour there, the aggregate area of the two openings below high-water, representing 20 per cent. of the mean area of the gorge above referred to, and make 15 per cent. of this aggregate opening on the Louisiana side or east jetty, I think we shall get nearly as full an inflow of tides as at present, but we shall get less discharge through the jetties than now, for the reason that fully 5 per cent., probably much more, must escape through the opening on the Texas side, and some, perhaps more than another 10 per cent., from the Louisiana opening. Therefore, with this loss of ebb volume through the jetties, they, to produce the same depth as we get in the gorge, should be closer together than the width of the pass at the gorge. We have shown, by a very rough calculation, that the volume of discharge of an ebb-tide, if flowing uniformly, would average about 77,727 cubic feet per second.

The jetties at South Pass of Mississippi River have a volume of water flowing through them varying from 26,688 to 78,410 cubic feet per second, and though only 1,000 feet apart are not sufficient to produce and maintain a channel such as we have in the gorge at Sabine Pass. Many inferences may be drawn from this, but the most plausible one is that, assuming my calculation of discharge for Sabine Pass to be approximately correct, then, with jetties 1,800 feet apart, we shall not get such a channel as the South Pass jetties now have. With the Sabine Pass jetties 1,000 feet apart (both high jetties) we might get 26 feet and more of depth, but fortunately Sabine Pass Bar does not require this depth.

Whether the jetties be placed 1,800 feet apart or less, it will make but a very small difference in their aggregate cost. Neither will the direction taken by the jetties make much difference in their cost, as the bottom on the bar, to the eastward and westward of the lines projected, is of the same character and has the same depth of water on it as is found on the lines indicated. The line selected has some advantages. It reaches deep water (the 20-foot curve) in about as short a distance as can be found; it covers or incloses what is left of the dredged channel, directs the ebb-discharge across, and very slightly with, the littoral current; and during southeast storms, which are generally the most severe in that vicinity, the jetties would take the storm and consequent sea at an acute angle, instead of broadside on, as would be the case were they deflected more to the westward.

A single jetty at Sabine Pass would probably produce much deeper water over the bar than is now found. Such jetty, if built, should be on the west side of the present channel, and should follow approximately the line laid down for the proposed west jetty shown on the chart. The reason for this side being preferable to one on the east side of the channel, is in consequence of the pressure or inclination of the ebb-tides toward the west. In consequence of the jetty we might get a scour on the east side of it from both tides, and as it would check the spread of the ebb in a westerly direction, we should get increased velocity and probably scour.

At all events, in the construction of jetties at Sabine Pass, one jetty would have to be commenced first; for reasons given, in my judgment it should be the west jetty. The foundation course of this jetty should be built nearly or quite its full length, before a second course is placed upon it. On the crest of the bar, where the water is only 6 feet in depth, the foundation course of the jetty will probably make some scour, which will continue to increase as the jetty is raised. As soon as a foundation mattress is laid and loaded with its stone to secure it, it should be covered with mud pumped on with a centrifugal pump. This will add to its weight, compact the stone, and possibly prevent the attack of the teredo; at all events, it will save quantities of stone, which is the most expensive ingredient of the jetty. When the jetty has been raised sufficiently high, the scour ought to be well remarked as well as the channel which it produces; this will then determine whether or not this jetty is to be raised higher or the other jetty to be commenced. As the difference between high and low water is only 1.4 feet, a high jetty will not very greatly exceed the cost of one reaching to low-water level.

The jetty or jetties, built or to be built, should have a sufficiently broad foundation, depending upon the depth of water in which they are placed, to be able to withstand the pounding of the seas without danger of overturning. The foundation mats, at least the outer ones, should be partly flexible rather than stiff or rigid, so that in the event of a close scour the outer portion will drop, and modify and possibly prevent further scour. In the estimates and designs submitted, I have estimated for a top 15 feet wide, with side slopes of 1 on 2, and always a berme 15 feet in width at the foot of this slope.

With regard to the kind of mattresses to be used in the jetties, we have on the Sabine and Neches rivers, within 50 miles of the pass, any amount of brush and logs, and at about 100 miles distant from the pass there are immense quantities of hard sandstone in the vicinity and on the line of the Eastern Texas Railroad where it crosses the Neches River. We can, therefore, have a choice of mattress material. Those constructed by Mr. Eads in the jetties of the Mississippi River consisted of willows and brush, confined by parallel layers of plank at top and bottom, the lumber being held together by hickory pins passing through the mattress and planks and then wedging the ends of the pins. This mattress is patented, and even were it not, it is probably no better and costs fully as much or more per cubic yard (in the history of the jetties by Mr. Corthell it is given as $8.97 per cubic yard in place) than the Dutch mattress now being used by Colonel Mansfield on the Texas coast.

The next mattress to be considered is that designed by General Gillmore for use in the jetties at Charleston. Its detailed construction is not known to me, but taking the simple log raft composed of 12 inches diameter logs, each 30 feet long, and using poles for binders, and iron drift-pins for fastenings, taking the cost of the logs at the prices the mills are paying for them, we get the following as the cost of a mattress 30 by 60 feet in plan by 18 inches deep, loaded with stone:

60 logs, each 30 feet long = 1,800 feet, at 5 cents per foot	$90 00
300 feet of 6" poles, at 3 cents	9 00
300 drift-pins = 198 pounds, at 4 cents per pound, driven	7 92
64.4 cubic yards of stone to sink it, at $4 per yard	257 60
Total	364 52

Making a volume of stone and logs of 3,600 cubic feet, or 133⅓ cubic yards, at a cost of $2.73 per cubic yard.

The Dutch brush and fascine mattress, as constructed by Colonel Mansfield at Galveston, assuming the cane to cost $5.25 per cord, brush $4.50 per cord, and stone $4 per cubic yard, which, I believe, are the prices now being paid, would cost about, for—

Wiepens	$24 09
Brush	94 95
Labor and ropes	65 00
44 cubic yards stone, at $4	176 00
	360 04

Volume = 30 × 6 × 2½ feet = 166.66 cubic yards = $2.16 per cubic yard.

The length of the west jetty projected on the map is 18,120 feet, its cubic contents to mean high-water level = 374,141 cubic yards; if built to 6 inches below mean low-water its contents will be about 304,578 cubic yards. The east jetty, measured on the straight line, is 19,800 feet long; measured on the curved line, its length is 19,180 feet. The contents of the straight jetty to mean high-water line = 407,877 cubic yards; to 6 inches below mean low-water = 336,468 cubic yards.

In the construction of jetties here it is probable that hearting mattresses can be used to within 3 or 4 feet of the surface of the water. If such be the case after the plant is available it is probable that they can be built in place at a cost of about $3 per cubic yard. At this price the

West high jetty would cost	$1,122,423	
West low jetty would cost		$913,734
East high jetty would cost	1,223,631	
East low jetty would cost		1,009,404
Totals	2,346,054	1,923,138

To the above amounts, whether we build one or more jetties, should be added the cost of plant, consisting of a good tow-boat, scows, pile-driver, powerful steam-pump, and mattress-way, aggregating about $50,000. We shall also have to do considerable piling to compact the jetties, for which I estimate 3,103 piles. each 30 feet (average) in length, at $3 each, driven = $9,309. It may also be necessary to dredge a channel between and above the jetties. The following estimate is for dredging so that the channel shall be 20 feet deep by 100 feet bottom width, with side slopes of 1 on 2, which will carry us into the 18-foot channel inside the bar. The estimate is only a rough approximation, and is about 800,000 cubic yards; this at 20 cents would cost $160,000.

The following is a résumé of estimate:

	West jetty.		East jetty.		Two high jetties.	Two low jetties.
	High.	Low.	High.	Low.		
Labor and material	$1,122,423 00	$913,734 00	$1,223,631 00	$1,009,404 00	$2,455,363 00	$1,923,138 00
Piling	4,654 50	4,654 50	4,654 50	4,654 50	9,309 00	9,309 00
Plant	50,000 00	50,000 00	50,000 00	50,000 00	50,000 00	50,000 00
	1,077,077 50	968,388 50	1,278,285 50	1,064,058 50	2,514,672 00	1,982,447 00
Contingencies, 20 per cent	235,415 50	193,677 70	255,657 10	212,811 70	502,934 50	396,489 50
Totals	1,412,493 00	1,162,066 20	1,533,942 60	1,276,870 20	3,017,606 50	2,378,936 50
Add for dredging (possibly)					160,000 00	160,000 00
					3,177,606 50	2,538,936 50

If we leave the dredging out of consideration, it would make the two high jetties cost at the rate of $3.85 per cubic yard. This is believed to be a little more than the actual cost per cubic yard of jetties thus far in place at Galveston. The material should cost less at Sabine than at Galveston, while the labor will cost fully as much or more. One jetty at Sabine Pass may produce 12 to 14 feet depth of water on the bar. Two jetties ought to produce much more, perhaps 24 feet, if placed less than 1,000 feet apart.

Except in the contingencies in the estimate, no account has been made of the subsidence which may occur to the jetties; the bottom is very soft, and we shall certainly have some settling, but just how much it is impossible to say. The steamer Clifton was wrecked on the crest of the bar fifteen years or more ago, and she still remains there, without having settled much.

The worms (teredo) are particularly destructive at the pass, and for that reason I deem it well to cover the mattresses with mud as soon after being placed as is possible.

With the money now available for Sabine Pass, $153,000, it might be well, as soon as the lines of the jetties are decided upon, to commence the construction of a single line of mattresses for foundation, commencing at the wreck of the *Clifton* and working outwards so far as the funds will permit. It is possible that with this money we can place one row of mats 40 feet wide with stone to sink and hold for a length of 7,000 feet, and would recommend that it, as well as subsequent work, be done by contract.

The commercial importance of the proposed work depends entirely on the railroads projected to terminate here. The grading for one road is partially completed to the town of Sabine Pass.

In 1872 it was reported that the value of domestic exports from Sabine Pass was $1,505,731.

The nearest port of entry is at Galveston, about 60 miles distant.

Accompanying this report is one tracing containing results of surveys from 1872 to the present time, and extending from outside of Sabine Pass Bar to beyond the town of Sabine Pass. It also contains the tidal curves for December, 1881, and profiles through proposed jetty lines.

A second tracing shows cross-sections of the pass at the town, and near the light-house, with current observations in each section.

In the event of appropriations being made for the jetties at this locality, the best and most economical results would be obtained by doing the entire work within three years from the time of its commencement. Seven hundred thousand dollars could be expended in jetties during the fiscal year ending June 30, 1883.

The area of water-way inside the bar, containing 18 feet or more of depth, is about 340 acres.

Respectfully submitted.

W. H. HEUER,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF THE BOARD OF ENGINEERS.

OFFICE OF THE BOARD OF ENGINEERS FOR FORTIFICATIONS,
AND FOR RIVER AND HARBOR IMPROVEMENTS, &C.,
New York, March 11, 1882.

GENERAL: This Board, to which was referred, by your letter of 6th instant, the report of Capt. W. H. Heuer, Corps of Engineers, relative to the improvement of Sabine Pass, Texas, has the honor to submit its views thereon as follows:

Sabine Pass, about 7 miles long, is the outlet of Sabine Lake, into which empty the waters of the Neches and Sabine rivers, depositing their mud sediment in the upper part of the lake in the form of bars. Navigation from Sabine Pass City to Beaumont, on the Neches, and to Orange, on the Sabine River, to large-class vessels, is obstructed by the above bars and by shoal water of the lake. Sabine Pass itself, with the exception of a bar about 900 feet long, has a least depth of 18 feet. But beyond the shore line where it enters into the Gulf of Mexico is a bar 18,470 feet, or about 3½ miles wide, between the interior and exterior 18-foot bottom curves, with little less than 7 feet water on its crest. As the waters of the rivers mentioned above deposit their sediment in Sabine Lake, this bar is evidently not made by deposit of material brought from those rivers, but is rather the natural coast formation of mud and fine material through which the inflowing and outflowing tides by reason of their dispersion have not the requisite velocity to cut and keep open a channel suitable for navigation by large vessels. Experiments have in fact shown that a channel cut through the bar fills rapidly by wave action in connection with that of the cross currents.

It would seem, from Captain Heuer's estimate, that the body of water flowing into and out from Sabine Pass will prove sufficient to keep open a channel across the bar if it be contracted into a narrow passage-way. The same inference may be drawn from the present depth of water in the Sabine Pass, especially where it is narrow.

With the exception of an oyster bar about 900 feet wide just below the city, Sabine Pass may be said to have an unobstructed channel 18 feet deep and upwards from the outer bar nearly to the lake. Where the pass is wide this channel is somewhat narrowed, but generally it exceeds 500 feet in width. The chart shows that a width of pass of 2,000 feet secures a sufficient channel, both as to width and depth.

Now, if jetties are built from the shore 1,800 feet apart, as proposed, across the bar to deep water, the pass is virtually prolonged 3½ miles and its mouth transferred to the same distance seaward. The funnel shape of the entrance-way will thus be lost and the surface slope of the channel of this elongated pass will be diminished, both of which changes will decrease tidal flow. To avoid the loss of the inflowing water, Captain Heuer proposes to make the east jetty low, or, if high, with a large opening at its shore end, while the west jetty is to be high with but a small opening inshore. If constructed in accordance with his views, doubtless the deeper layers of water coming down the pass by reason of their living force will move on between the jetties, but with some diminution of velocity, while the upper or surface layers will seek by the east and west openings in the jetties the shortest line to the Gulf level.

It may well be a question whether the gain in the amount of the inflowing tide by leaving openings through the jetties near their shore ends will compensate the loss in scouring effect of the outflowing between the jetties due to diminution in volume and velocity of movement, which will be the more marked as the jetty lengths are increased.

It is an objection to these openings, as well as to the submerged jetties, that they will permit material to be brought into the pass, and the more so as in this locality the winds blow obliquely upon the shore for the greater part of the year, stirring up the bottom not only during storms far seaward, but in the shoaler water by the smaller waves of translation due to moderate winds. This material will be deposited more or less irregularly in the pass, to be either stirred up by the outflowing tide or rolled along the bottom between the jetties, creating variations of depth and irregularity of channel until it reaches the sea.

In this connection should be noticed the great variation in the tides due to the winds—nearly 4 feet. It seems probable that from that cause much irregularity of depth in the channel of the pass and between the jetties (whether low or high) would be produced.

While we freely admit that the jetties would give a much deeper channel than at present, we do not think they will by any means secure an unchanging depth equal to that now maintained in the pass.

We prefer high jetties to the submerged, and would, even in using them, omit the shore openings. If, therefore, a deeper channel through the Sabine Pass be now demanded, the western jetty, as proposed by Captain Heuer, should be built first (but without shore openings), and its effect observed. It is not necessary to decide at present in reference to the eastern, although this Board would favor a high jetty without shore openings to a low one on that side of the channel as well as on the western.

In conclusion, we would add that we do not feel called upon to enter on a prolonged discussion of this subject, as it is treated so fully and satisfactorily by Captain Heuer in his report referred for our consideration.

Respectfully submitted.

Z. B. TOWER,
Colonel of Engineers, Bvt. Maj. Gen.
JOHN NEWTON,
Colonel of Engineers, Bvt. Maj. Gen.
HENRY L. ABBOT,
Lieutenant-Colonel of Engineers, Bvt. Brig. Gen.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

APPENDIX O.

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATE OF TEXAS.

REPORT OF MAJOR S. M. MANSFIELD, CORPS OF ENGINEERS, BVT. LIEUT. COL., U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Entrance to Galveston Harbor, Texas.
2. Ship channel in Galveston Bay, Texas.
3. Trinity River, Texas.
4. Buffalo Bayou, Texas.
5. Channel over bar at mouth of Brazos River, Texas.
6. Pass Cavallo Inlet to Matagorda Bay, Texas.
7. Aransas Pass and Bay up to Rockport and Corpus Christi, Texas.
8. Harbor at Brazos Santiago, Texas.
9. Protection of river bank at Fort Brown, Texas.

EXAMINATIONS AND SURVEYS.

10. Matagorda Bay, at the mouth of Saint Mary's Bayou, near the town of Matagorda, Texas.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., August 3, 1882.

GENERAL: I have the honor to forward herewith my annual reports relating to the works of river and harbor improvements under my charge for the year ending June 30, 1882.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Major of Engineers,
Bvt. Lieut. Colonel, U. S. A.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

O 1.

IMPROVEMENT OF ENTRANCE TO GALVESTON HARBOR, TEXAS.

At the close of the year ending June 30, 1881, the improvement at this entrance, under the approved project of 1880, consisted of extension—

To north jetty.—From outer end of the Bolivar gabionnade, one layer of mattresses 90 feet long, 60 feet wide, and, with its concrete-ballast, 2½ feet high above the sand bottom—an experimental work to note behavior of the mattresses under the new system.

To south jetty.—Commencing in 6 feet of water at a point located 3,300 feet from the outer end of the Fort Point gabionnade, one layer of mattresses 7,827 feet long and 2½ feet high, of which 5,846 linear feet had a width of 60 feet, and 1,981 linear feet a width of 90 feet.

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1882.

From the beginning to the close of the year all work was concentrated upon the south jetty. For sufficient reasons, the work of improvement was carried on by hired labor, with aid of plant owned by the government, or hired for the occasion, when emergency called, and by purchase of brush, cane, cordage, stone, and other materials incidental to the work in hand in open market, or by contract, when time permitted for advertising in the usual way.

Under the appropriation of $250,000 (act of March 3, 1881) contracts were entered into with the following-named parties for the delivery of stone, brush, cane, and cordage:

1. *Gulf, Colorado and Santa Fé Railway Company—Stone.*—Contract began the middle of June, and was completed September 15, by the delivery of 5,351.335 tons in the aggregate.
2. *Shannon & Hyatt—Brush and cane.*—Contract began in July, and was completed March 8, 1882, when final payment was made and contract closed. Amounts delivered under this contract: brush, 17,154.96 cords; cane, 1,396.16 cords.
3. *Theo. K. Thompson—Cordage.*—Contract began in July, and was completed the end of August by the delivery of amount needed, viz, 40,253 pounds ratline, 9,147 pounds 3-inch manilla rope, and 10,978 pounds of lath-yarn.

The contract with the Gulf, Colorado and Santa Fé Railway Company for stone, was limited, in accordance with proviso in its bid, to 2,000 tons per month delivery, for a period of time just falling short of three months, with an understanding, however, that any quantity in excess of 2,000 tons should be received, if delivered in a month, up to and within the limit of 18,000 tons, the amount called for by the advertisement, in the aggregate.

By the middle of August it was found that the railway company was unequal to the task of furnishing more than the stipulated monthly delivery, which would aggregate at the close of the contract but little more than 5,000 tons. For reasons, and as explained in letter of August 19, 1881, to the Chief of Engineers, it was considered proper to seek in open market for a supply of stone to meet the deficiency; and in conformity to instructions contained in letter of August 26, Office of the Chief of Engineers, a bid of Messrs. Hitchcock & Byrnes, of Galveston, to furnish 10,000 tons of stone, at $4.70 per ton, was entertained. Approval of this bid was granted by letter of October 15, 1881, Office of the Chief of Engineers.

Messrs. Hitchcock & Byrnes began delivering stone in January, 1882, and completed the delivery of the 10,000 tons June 6, 1882. After the close of the contract with the railway company, and in accordance with a verbal agreement with the president of the company, under the authority given to purchase in open market, intermediate deliveries of stone were made from the Gulf, Colorado and Santa Fé Railway Company's quarries from October, 1881, to April, 1882; in all, 5,446.58 tons. The handling of all stone received, transfer to barges, &c., was done by Munn, Fry & Company, of Galveston, under authorized agreement.

There being a balance of funds remaining after the close of the brush contract, Mr. Shannon (firm of A. M. Shannon & Co., formerly Shannon

& Hyatt) was permitted to continue the delivery of such brush (at contract price) as was imperatively necessary, until time for the delivery of material under the special appropriation of $100,000, act of March 4, 1882. Advertisement for such material required calling for the opening of bids on the 18th of April; 4,000 cords of brush were so delivered by A. M. Shannon & Co. during March and April.

The project for the expenditure of the amount ($100,000) given by special act of Congress approved March 4, 1882, recommended continuation of work of improvement as before, viz, construction of south jetty by the use of brush-mattresses and stone-ballast; brush, cane, stone, cordage, and iron thimbles to be procured under contract after advertising in the usual way; incidentals to be purchased in open market, and the labor of constructing, handling, and sinking mattresses to be hired.

Contracts were entered into with—

1. H. Marwitz & Co., May 4, for furnishing spun yarn, sisal, iron thimbles.
2. Aldolph Flake & Co., May 8, for furnishing ratline.
3. Gulf, Colorado and Santa Fé Railway Company, May 8, for stone.
4. Burnett & Ross, May 10, for furnishing cane.
5. A. M. Shannon & Co., May 19, for furnishing brush.
6. Isaac Heffron, May 19, for handling stone.

During July, August, and September the work was impeded to some extent by the want of sufficient stone wherewith to sink the mattresses in position; in every way otherwise all was perfectly satisfactory. But in October, and for the first three weeks in that month, the high-tides, strong currents, and generally squally weather materially hindered the progress of work, and at the same time caused the loss of twelve mattresses, placed in the water ready to be towed to jetty, of which number three were broken up, four were beached at Pelican Spit, and five were lodged on channel beach opposite Eighth and Twelfth streets, at the east end of Galveston Island, in line of breakwater, where they will act servicably as a revetment.

December was an exceptionally progressive month; 72 mattresses—40 placed in seven consecutive days—were added to the jetty, terminating and locating the outer end of the foundation course a distance of 16,515 feet from the initial point, and resting beyond the bar crest in a depth of 13½ feet. The second mattress tier was begun this month by the placing of one mattress 95 by 30 by 1½ feet upon the foundation course at a distance of 46 feet inward from the outer end.

Unfavorable weather was experienced during January, February, and March, and the construction of the jetty progressed unsatisfactorily. In April I was forced to withdraw the tug Cynthia from the work and put her in the hands of workmen for thorough repair. The tug Molyneux, repaired in March at some expense, after her return from Galveston from service at Aransas Pass, was available, and, aided by certain tugs hired in April, as required, the prosecution of work on jetty continued.

In the storm of May 7 and 8, a tow of six mattresses and a barge loaded with 70 cords of brush were torn from their anchorage and carried out to sea. The action of the seas broke the mattresses to pieces, causing their loss. The barge, relieved of a portion of its load of brush, after hanging by her anchor one day on the line of the jetty and near its outer end, was driven upon the beach at Bolivar Point, from where it was recovered, receiving very little damage. This storm was as severe a strain upon our work as it will ever be called upon to endure; not the slightest injury occurred.

I think it proper to submit here the following letter:

OFFICE OF MALLORY LINE,
Galveston, Tex., May 10, 1882.

MY DEAR SIR: Yours of this morning, conveying the glad intelligence that upon examination your jetty had withstood the storm of Saturday and Sunday, remaining intact and in place, is received.

It has been, in my judgment, as severe a test as it is likely to have again during the course of its construction, and is very gratifying, inasmuch as it gives confidence in its permanency and insures the success of your grand enterprise.

I take much pleasure in writing my congratulations upon your victory gained of *holding quicksand down by ballasted mattresses* in heavy-rolling breakers during a protracted gale of unusual severity. I take the liberty of mailing your note to Messrs. C. H. Mallory & Co., and am, sir,

Yours, very truly,

J. N. SAWYER.

Col. S. M. MANSFIELD.

The principal work on the south jetty during the last half of the year has been the placing of mattresses in lateral extension of the foundation course, giving it full width of 120 feet where found desirable and necessary, extending second tier of mattresses (all of which were 15 by 95 feet, excepting the two outer ones at extreme outer end, which were 30 by 95 feet) inward; building shore-connection at Fort Point; placing mattresses in direction of closing the gap left at shore-end of the jetty, and riprapping and securing portions of the work by the deposit of extra ballast at points requiring it.

At the close of the year (June 30, 1882) the condition of the works was as follows:

1. The small "trial-section" of mattress-work on line of north jetty, 90 feet long, remained in the same condition as when first put down.

2. The south jetty extension comprised mattress and stone work of successive lengths and widths, viz:

The total distance of the extreme ends of the jetty apart, measured along the axis, is 22,551 feet, with a gap of 1,774 feet, making the total length of the jetty 20,777 feet. Of this—

1,270 feet is 30 feet wide.
7,740 feet is 60 feet wide.
7,550 feet is 90 feet wide.
4,217 feet is 120 feet wide.

The length of the second course is 10,130 feet, of which—

290 feet is 30 feet wide.
9,480 feet is 15 feet wide.
360 feet is 10 feet wide (stone only).

It will be seen from the foregoing that great progress has been made in the construction of this jetty. Its great length of 4 miles, extending over shoals of quicksand covered with breakers, except in calm weather, directly out over the bar into the Gulf of Mexico, has been almost entirely completed, and this, too, within the space of two years, and without a mishap of any kind, and with but trifling loss of material. We might say we have lost nothing, for out of the seven hundred and forty-one mattresses placed in the jetty only three are known to have been carried away.

There has been used in the work—

36,585.17 cords of brush and cane.
34,549,325 cubic yards of stone and concrete.

The brush and cane was brought from the rivers and bayous at the head of the bay, a distance of from 30 to 75 miles.

The stone was brought direct by rail a distance of 140 miles, with the

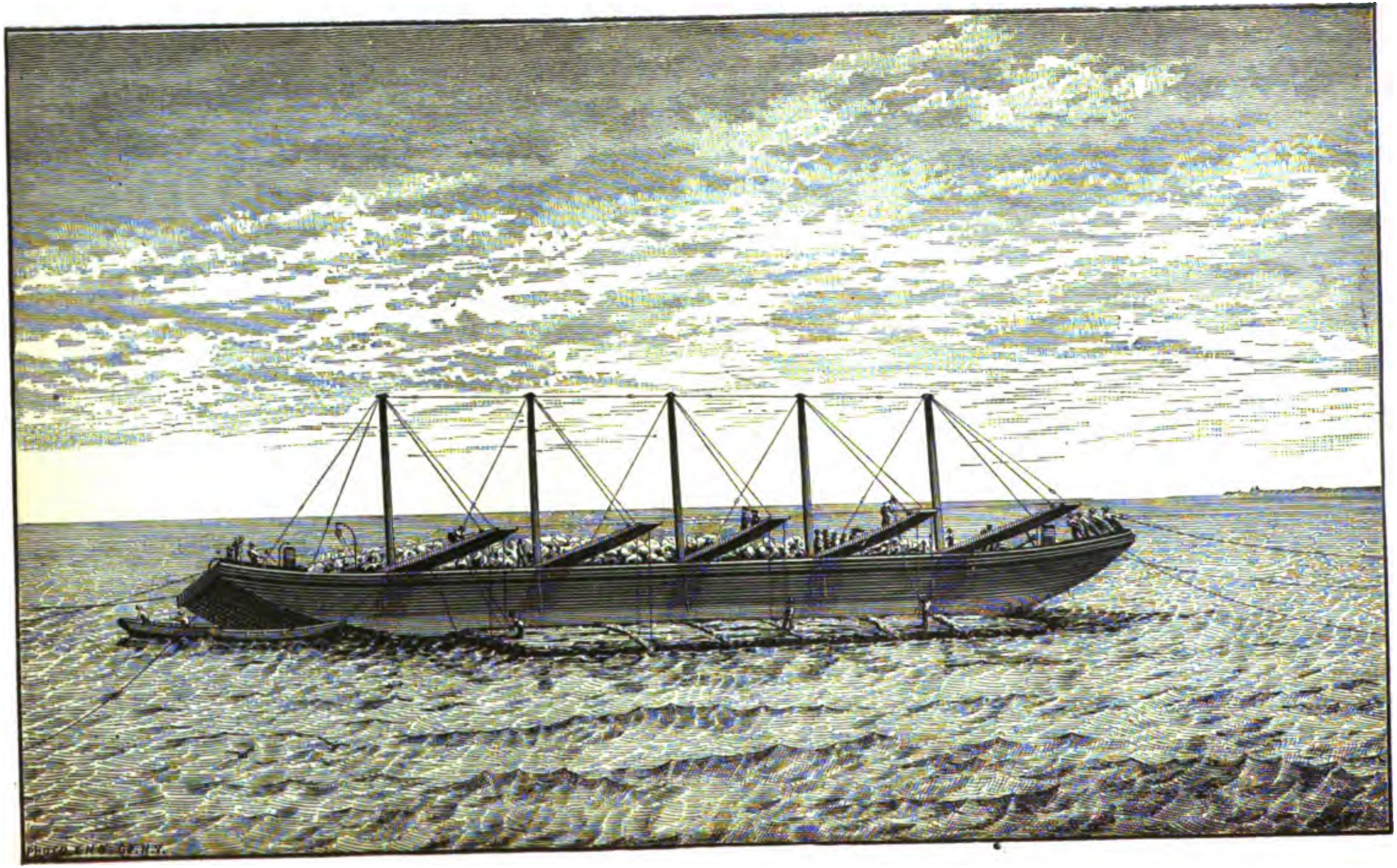


PHOTO-ENG. CO. N.Y.

GALVESTON HARBOR IMPROVEMENT.

[Sketch showing manner of placing mattresses in the jetty. Barge, 130′ × 40′ × 7½′.]

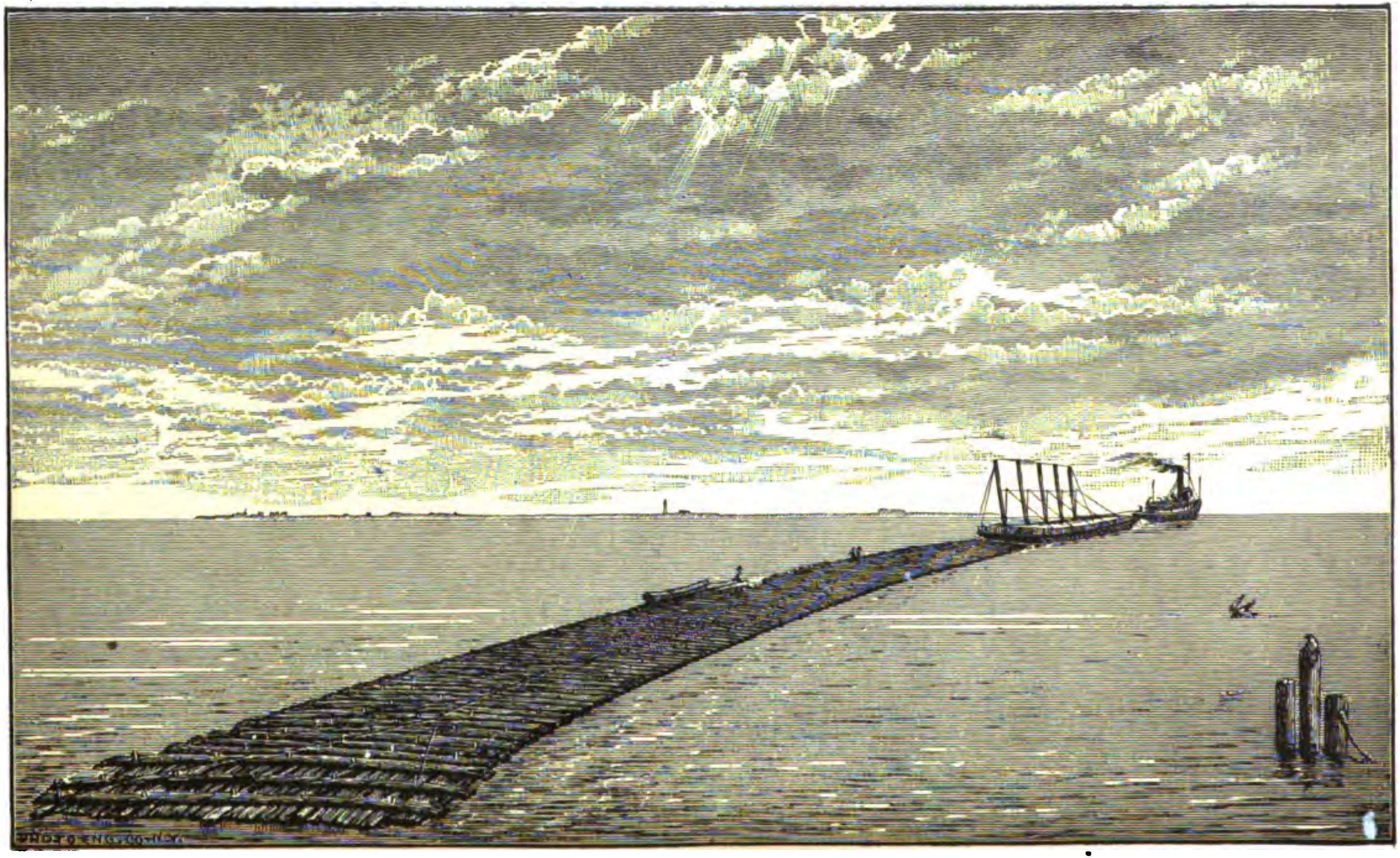


PHOTO-ENG. CO. N.Y.

GALVESTON HARBOR IMPROVEMENT.

[Sketch showing tow of barge and mattresses.]

exception of 10,000 tons brought by rail to Houston, a distance of over 100 miles, there transferred to barges and brought down the bayou and ship-channel 50 miles, and again transferred to our own barges.

During the past year (see report of superintendent, Mr. W. A. Hinkle) one hundred and forty-one days were favorable for placing mattresses in the jetty, and forty-nine of them were lost to us by circumstances we could not control. Nevertheless, five hundred and twenty-one mattresses were placed, an average of over five a day for the working days.

No skilled labor has been employed, and the wages paid are such as prevail in this locality; material has been obtained by contract whenever practicable; when otherwise, on competitive bids of dealers in the articles required.

The strictest economy has been practiced consistent with good and rapid work.

There has been placed in the work during the year 84,085.97 cubic yards of brush mattresses and 27,306.92 cubic yards of ballast, a total of 111,392.89 cubic yards, at a cost of $317,843.48. If to this cost we add our engineering and office expenditures, $3,549.74 (a little over 1 per cent.), we have a total of $321,393.22 as the cost of constructing 111,392.89 cubic yards of jetty, or $2.88½ per yard. My original estimate was $3.83 per yard.

It is believed our measurement is under the actual, as we have considered as the thickness of the mattress only the thickness of the brush filling.

From the quality of the brush, permitting it to compact closely, and the compression to which it is subjected in quilting the mattress, it can hardly be expected to be compressed further by any amount of ballast likely to be placed on it; while we know, too, the interstices of the mattress become at once filled with sand when placed in position.

By the detailed report of Assistant Engineer, H. C. Ripley, herewith, it will be learned that very little loss has been occasioned by settlement; what little has occurred is chargeable to our inexperience in work of this character. Defects of construction were early discovered and quickly remedied, and it is believed no further settlement is possible.

I have endeavored in this report to give a clear idea of this work in all its details, as it is thought it may be found interesting and instructive to others who may have works of a similar character in charge.

RESULTS OBTAINED.

The effect of this work at the present time is not such as one not familiar with the physical phenomena of our locality would be led to expect from the amount of work accomplished.

The most important part of our work, and that from which we expect good results, has been all placed since last winter, and we must therefore, for a realization of benefits, await the action of the strong ebb-currents that will accompany the northers of next winter. As the result of our work of last season, which did not extend above the foundation layer of mattresses and to a point far short of the crest of the bar, vessels were enabled to cross the bar drawing from 1 to 2 feet more water than formerly.

In addition to this we find that, in consequence of the presence of our jetty, pilots are enabled to work the bar in much rougher weather than they formerly could.

A great improvement is acknowledged by the pilots and shipping interests; all admit it without exception, and the records of the pilot office for the past year show an average increase of depth of more than a foot over former years.

Changes that have occurred in the channels and shoals adjacent to and attributed to the presence of the jetty are carefully detailed by Mr. Ripley.

Indications all point to a successful result. It is not unreasonable to expect a very great improvement of the bar upon the advent of this fall's storms.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1883.

The funds of the special appropriation of $100,000, act of Congress approved March 4, 1882, are practically exhausted. With the appropriation for the fiscal year 1882–'83 ($300,000), it is thought that the south jetty will be completed as designed; and, as the tugs, barges, &c., are in good working order, and there being every prospect of sure and prompt delivery of material required, it is possible, with favorable weather, to push the work to completion this season.

The work should continue in the same manner as it has from the beginning, viz, by the purchase of stone, brush, cane, cordage, and thimbles under contract, after advertising for proposals in the usual manner; incidentals to be purchased in open market; labor to be hired.

Estimates for improvement here, in accordance with approved plan (1880), amount to	$1,825,813
Appropriated 1880–'82	825,000
Unappropriated balance	1,000,813

Five hundred thousand dollars could be very profitably expended in the fiscal year ending June 30, 1884, in continuing the work of improvement.

The work is located in the collection district of Galveston. The nearest light-houses are on Bolivar Point and Fort Point, at entrance to Galveston Bay.

Money statement.

July 1, 1881, amount available		$264,791 45
Amount appropriated by act approved March 4, 1882		100,000 00
		364,791 45
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$310,024 18	
July 1, 1882, outstanding liabilities	54,767 27	
		364,791 45
Amount appropriated by act passed August 2, 1882		300,000 00
Amount (estimated) required for completion of existing project		1,000,813 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		500,000 00

Abstract of proposals for furnishing material, &c. (Galveston Harbor, Tex.), received in response to advertisement dated April 3, 1882, *and opened April* 18, 1882, *by Maj. S. M. Mansfield, Corps of Engineers.*

	Names of bidders.	Ratline, 15,000 pounds.	Spunyarn, 14,000 pounds.	Sisal, 8,500 pounds.	Thimbles, 700 pounds.	Brush, 5,500 cords.	Cane, 1,000 cords.	Stone, 10,000 tons.	Handling stone.	
		Cents per lb.	*Cents per lb.*	*Cents per lb.*	*Cents per lb.*	*Per cord.*	*Per cord.*	*Per ton.*	*Per ton.*	
1	H. Marwitz & Co	9.90	9.15	7.65	8½					Lowest.
2	Levi H. Jones								$0 24	
3	Rosamond, Milam & Brother					$3 50				
4	William H. Harding							$3 50		
5	Longshoremen's Stock Association								24	
6	L. M. Waters					4 00	$6 50			
7	A. M. Shannon & Co					3 45	6 50	3 40		Lowest.
8	Gulf, Colorado and Santa Fé Railroad Company							3 25		Lowest.
9	Edward Lynch								20	
10	Burnett & Ross					3 70	5 85			Lowest.
11	Isaac Heffron								19	Lowest.
12	Adolph Flake & Co	9⅞	9¼	8	9¾					Lowest.
13	Charles Clarke								27½	
14	Antony Brock	10¾	9¾	8¼	10½					
15	Andrew Munn								31	
16	Garcia & Freiberg					3 90				
17	James Joseph Delahanty								26	
18	Scott & Davis								36	

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, GALVESTON, TEX.,
Collector's Office, July 11, 1882.

DEAR SIR: In compliance with your request, I take pleasure in handing you the following statement showing the tonnage of this port for the fiscal year ending June 30, 1882:

Coasting trade:

	Tons.
Entered, 480 vessels	507,669
Cleared, 429 vessels	443,361

Foreign trade:

Entered, 218 vessels	144,715
Cleared, 185 vessels	115,579

Very respectfully, &c.,

A. G. MALLOY,
Collector.

Col. S. M. MANSFIELD,
United States Corps of Engineers.

REPORT OF MR. H. C. RIPLEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 26, 1882.

COLONEL: I have the honor to submit the following report relating to the improvement of Galveston Harbor, Texas, for the fiscal year ending June 30, 1882:

The following tracings accompany this report:

Sheet A. Chart of the harbor.
Sheet B. Plan and elevation of south jetty.
Sheet C. Cross-section of same.

Sheet D. Detailed views of portions of the same.

Since the placing of the first mattress in the south jetty, July 13, 1880, a careful record has been kept showing the position of each mattress, date of placing, amount of ballast used, the depth of water before and after placing, the direction of the littoral current, and the direction of the current at the locality of the mattress. Tide records have also been kept at the government wharf near the city and at Fort Point. The mattresses have been numbered consecutively in the order of their placing.

From these records the mattresses have been plotted on a large scale, showing their positions in the jetty both in plan and elevation. A small portion of this plot is shown on Sheet D, Fig 1.

Examinations have also been made from time to time, as the work has progressed, to determine the changes produced by the jetty, and also to ascertain the behavior of the jetty itself.

From the records of jetty construction, and from the examinations made from time to time, the plan and profile shown on Sheet B have been plotted. But little explanation of this sheet is needed beyond what is given on the sheet itself. The shaded portion of the elevation shows the actual height of jetty attained. The full black line shows the outline of the proposed completed jetty.

The total distance of the extreme ends of the jetty, a part measured along the axis, is 22,551 feet, with a gap of 1,774 feet, making the total length of the jetty 20,777 feet. Of this—

1,270 feet is 30 feet wide.
7,740 feet is 60 feet wide.
7,550 feet is 90 feet wide.
4,217 feet is 120 feet wide.

The length of the second course is 10,130 feet. Of which—

290 feet is 30 feet wide.
9,480 feet is 15 feet wide.
360 feet is 10 feet wide; stone only.

BEHAVIOR OF THE JETTY.

The behavior of the jetty is shown by the cross-sections, Sheet C, and by Figs. 2, 3, and 4, Sheet D.

By an inspection of the plan, Sheet D, Fig. 2, it will be seen that these mattresses were placed at right angles to the line of the jetty, leaving continuous joints across the jetty. The result has been that a scour between the mattresses has produced a settlement which amounts to an average of 1.74 feet for a distance of 1,372 feet. A change in the manner of placing the mattress, so as to obviate the continuous joint, as shown in Fig. 1, has entirely remedied the difficulty, save, perhaps, in some rare cases, which will be noticed further on. It might be further stated that this portion of the jetty was an experimental portion; the mattresses were smaller than have been since used for the foundation course, and for the want of proper facilities, or from inexperience, the mattresses were not placed in good contact.

Figs. 3 and 4 show how admirably the mattress adapts itself to the bottom, where there is a tendency to scour and imposes a barrier to its further progress.

A recent examination at the point shown in Fig. 3 shows that no further settlement or undermining has occurred.

With regard to the cross-sections, Sheet C, it should be remarked that where the character of the bottom is given as brush it simply indicates that the sounding-pole was on brush when the sounding was taken, although there may have been rock immediately alongside.

Sections No. 1 and No. 1′ were taken at the same point on the center line of the jetty, but are not exactly coincident throughout. Each shows a slight scour and subsequent fill on the north or channel side of the jetty, and a slight scour but no undermining on the south side. Section No. 2 shows a difference in depth on the opposite sides of the jetty of 6¼ feet. It should be remarked, however, that on account of its proximity to the wreck the depth was greater on the south than on the north side when these mattresses were placed, and hence it is not certain that any scour has occurred since the placing of the mattresses at this point.

Section No. 3 shows that after the placing of the central mattresses a scour and subsequent fill took place before the outside mattresses were placed. This section was taken before the second course had reached this point.

Section No. 4 shows how the central mattresses, which had been in place about four and a half months, had settled at their edges to conform to the scour on either side. It also shows that the sand had entirely filled the interstices of the brush on the south side. It may be here remarked that this is generally the case in the foundation course that the interstices of the mattress is filled with sand, except for a few inches of the surface. In driving a pile recently through the jetty near the outer end there was evidence that the sand had also filled the interstices of the mattress of the second course. Since this section was taken one mattress on the north side and the second course mattress have been placed.

Section No. 5 shows an undermining of the edges and subsequent fill, chiefly on the north side.

Sections No. 6 and No. 7 show less undermining, and sections No. 8 and No. 9 show none at all on the north side, and No. 9 shows some fill there.

Section No. 10 shows a decided undermining of the north side and subsequent fill, and a scour without any undermining on the south side.

Sections No. 11 and No. 12 show a fill on the north side and scour on the south side without any undermining on either side.

Section No. 13 shows a fill on the south side and an apparent settlement of the north mattress. This is not the case, however, but after the south mattress was placed a scour occurred on the north side of it, and into this trench the north mattress was placed. By some unknown cause the north mattress became broken and some of the brush escaped.

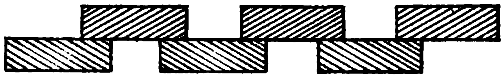
Section 14 was taken across the center of mattress No. 606 and near the end of No. 605. It shows a settlement of No. 606 of from 2¼ feet to 3¼ feet, and either a disappearance of No. 605 or a settlement and subsequent covering with sand. No cause can be assigned for this settlement. The situation is such as to subject it to strong currents both across the jetty and along its north face. It is also much exposed to the breakers.

Section No. 15 shows the sand banked against the south side of the jetty quite up to the top of it, and without any apparent undermining on either side.

In addition to what is here shown, it should be stated that at the end of each day's work, unless the weather was calm, more or less undermining of the end of the jetty and a scour for a short distance in advance occurred. In a few instances, after severe storms, the end mattresses were found to be injured, and two mattresses placed October 26, 1881, at the then outer end of the jetties were carried away by a storm, which occurred the following night.

Mattress No. 603, placed May 16, 1882, in the second course, was also carried away May 30, and replaced by No. 645 June 1, 1882. These three mattresses are the only ones known to have been carried away from the jetty since its construction commenced.

Six mattresses placed October 17, 1881, in this manner,



extending out from the end of the pile breakwater, on the line of the jetty, became undermined and settled so much, and afterwards covered with sand, that when work was resumed at that point, March 29, 1882, all that could be found, with the exception of one mattress, and that greatly settled, was an occasional lump of brush and stone. There has also been some settlement of the jetty at one point near the Fort Point light-house, where the base was 60 feet wide, and mattresses properly placed breaking joints, and before the second course was placed. The cause and nature of this settlement has not been fully determined. It took place during a violent storm which occurred in May, at the end, at that time, of that portion of the work.

CHANGES.

A comparison of Sheet A with a survey made during the months of December, 1880, and January and February, 1881, shows less favorable change than might have been expected from the amount of jetty constructed. Along the south side of the jetty for a distance of 2 miles from the outer end a trench has been scoured from 3 feet to 6 feet deep near the edge of the jetty and sloping up to the normal depth at a distance of from 200 feet to 500 feet. This scour is undoubtedly due to overfall caused by the spread of the outgoing tide and by the littoral current flowing to the southwestward. There has also been a deepening along the south side of the jetty at a point about 1 mile east of Fort Point light-house. Aside from these trenches near the jetty, and a slight movement northward of the swash-channel near its inner end, caused by the building of the inner end of the jetty, there has been a general shoaling over the whole area south of the jetty embraced in this survey of from half a foot to 2¼ feet. Near the inner end of the jetty there has been a shoaling amounting to as much as 6 feet in places. The high-tide shore line has also advanced about 400 feet, quite effectually closing the head of the swash-channel. On the north side of the jetty there has been a deepening at two points.

Across the shoal south of the light-vessel, a narrow trench has been scoured along the jetty with a maximum depth of 10 feet, and sloping up to 6 feet depth at a distance of about 200 feet from the edge of the jetty; and a very decided deepening has taken place along the face of the jetty for a distance of 2,000 feet from the end of the pile breakwater. Beyond this a shoaling has occurred which has resulted in driving the 18-foot contour out of the channel, crossing the line of the jetty, about one mile east of Fort Point light-house, and in pushing the 12-foot contour from a point directly south of the light-vessel to where it approaches the jetty farther east, north about 400 feet and east about 800 feet. Over the whole area extending from the jetty to Bolivar Channel, and from the light-vessel across the bar, except on the crest of the bar, a shoaling has occurred which amounts approximately to an average of 1 foot. The 18-foot contour on the south side of Bolivar Channel for 4,000 feet from its eastern end has moved northward about 400 feet, and the 12-foot and 18-foot contours, beyond the crest of the bar, have moved gulfward a distance of from 300 to 500 feet. Immediately in front of Bolivar Channel no shoaling has occurred until the crest of the bar is reached. Along the crest, in front and to the north of the channel, there has been an apparent shoaling of from half a foot to 1 foot.

The only place on the crest of the bar where the depth of one and a half years ago has been maintained is through the channel contiguous to the jetty, and even here there are spots where shoaling has occurred. A slight shoaling has also occurred in Galveston Channel west of Fort Point light-house, caused by sand brought in through the swash-channel. The head of this channel is now closed, and it is believed that Galveston Channel will soon resume its normal depth. The depth on the inner bar remains substantially unchanged. The changes in Bolivar Channel beyond those already noted are unimportant. Its eastern extremity is almost exactly where it was at time of last survey.

The causes of most of these changes are easily explained. The building of the inner portion of the jetty has caused a scour on the adjacent shoal, and the material has been deposited in the channel beyond, and the enfeebled current of this channel has been unable to remove it.

The shoaling south of the jetty is caused by southerly winds, which bring the sand in from the long shoal extending southward. A portion of this sand is carried across the jetty at a point nearly south of the light-vessel and deposited on the north side of it. The outgoing tide, unable to force it back to the southward as formerly, on account of its weakened power in that direction, due to the height of the jetty, pushes it to the eastward and so extends the shoal in that direction. It is quite certain that the sand moves as here indicated, from the fact that the sand is banked up against the jetty on the south side at this point, showing the direction of its movement, and the trench on the north side at the same point must be caused either by the overfall during this movement or by the scour of the outgoing tide, showing its direction to be along the jetty at this point rather than across it.

With regard to the shoaling on the crest of the bar, it should be remembered that during the winter months, when the northers prevail, is the time of greatest scour on the bar; and during the summer months, or during the absence of northers and the prevalence of easterly and southeasterly winds, the crest of the bar is always shoaled. Now, this survey was made in midsummer and only a short time subsequent to a very severe easterly storm, which was not accompanied nor followed by any extraordinary outgoing tides, while the survey with which it is being compared was made in midwinter, and it is believed that to this cause may be attributed the apparent shoaling where there was every reason to expect a deepening. This belief is further strengthened from the fact that, on the 6th of December last some soundings taken through the jetty channel gave two lines across the bar with a least depth of 12¾ feet at mean low-tide; which is 1¼ feet greater than the deepest line of soundings across the bar of the present survey.

Very respectfully, your obedient servant,

H. C. Ripley,
United States Assistant Engineer.

Bvt. Lieut. Col. S. M. Mansfield,
Major of Engineers, U. S. A.

REPORT OF MR. W. A. HINKLE, SUPERINTENDENT.

United States Engineer Works,
Galveston, Tex., July 8, 1882.

Colonel: I have the honor to submit my report of operations on the improvement of harbor at Galveston, Tex., for the fiscal year ending June 30, 1882.

The work consisted in the manufacture and placing of mattresses and repair of plant.

On hand July 1, 1881, 11 mattresses, 30′ x 95′ x 1′.6.

There have been constructed—

424 mattresses, 30′ x 95′ x 1′.6.
1 mattress, 30′ x 82′ 5″ x 1′.6.
1 mattress, 30′ x 80′ x 1′.6.
1 mattress, 30′ x 60′ x 1′.6.
1 mattress, 30′ x 54′ x 1′.6.
1 mattress, 30′ x 45′ x 1′.6.
108 mattresses, 15′ x 95′ x 1′.4.

Making a total of 537 mattresses.

There have been placed in line of south jetty—

Foundation course:

412 mattresses, 30′ x 95′ x 1′.6.
1 mattress, 30′ x 82′ 5″ x 1′.6.
1 mattress, 30′ x 80′ x 1′.6.
1 mattress, 30′ x 60′ x 1′.6.
1 mattress, 30′ x 54′ x 1′.6.
1 mattress, 30′ x 45′ x 1′.6.

Making a total (in foundation course) of 417 mattresses.

In second course there have been placed—

2 mattresses, 30′ x 95′ x 1′.6.
102 mattresses, 15′ x 95′ x 1′.4.

Making a total (in second course) of 104 mattresses.

Total number of mattresses placed in south jetty, 521; leaving 6 mattresses on hand June 30, 1882.

In this work there has been used the following material:

Cords of brush	24,963.15
Cords of cane	1,445.31
Pounds of lathyarn	13,428
Oak stakes	32,037
Pounds ratline	72,859
Pounds 3-inch manilla rope	10,750
Pounds 3-inch sisal rope	3,727
Pounds iron thimbles	2,833
Pounds spun yarn	33,302
Cubic yards stone	27,125.92
Cubic yards concrete	181

COST OF WORK.

Manufacture of mattresses	$31,630 55
Repairs of plant	17,047 11
Placing mattresses in south jetty	27,224 99
Storing and cost of stone	98,041 69
Surveys	1,010 14
Superintendent, clerks, and watchmen	9,037 34
Storing and cost of brush and cane	118,466 82
Marline, rope, and ratline	15,345 34
Other harbors	39 50
	317,843 48

NOTE.—Number of cubic yards of ballast placed in south jetty, 27,306.92.

Number of cubic yards of brush-mattress work placed in south jetty, 84,085.97.

Statement showing number of days of favorable weather and the number of mattresses placed during the year.

Months.	Number of days favorable for sinking mattresses.	Number of mattresses placed.	Number of days lost, and cause.
1881.			
July	16	68	Three days, no stone; one day, no mattresses; and one day, holiday.
August	17	46	Nine days, no stone; one day, Sunday.
September	11	33	Four days, no stone; one day, repairing tug Cynthia; one day, receiving brush.
October	6	39	
November	9	21	One day, no stone; four days, repairing tug Cynthia.
December	15	72	Two days, no stone.
1882.			
January	5	7	One day, no stone; three days, no mattresses, out of brush.
February	7	17	Three days, repairing tug Cynthia.
March	11	51	One day, current too strong to tow mattresses with tug Molyneux—tug Cynthia under repairs.
April	9	29	Three days, current too strong to tow mattresses with tug Molyneux—tug Cynthia under repairs.
May	16	57	One day, making survey; one day, repairing tug Molyneux; two days, current too strong to tow mattresses with tug Molyneux—tug Cynthia under repairs.
June	19	81	One day, making survey; three days, no stone, barges loaded; two days, Sundays.
	141	521	

There were twenty-one mattresses lost, as follows: Three broken up by heavy seas at south jetty before sinking; twelve were water-logged from long remaining in the water during prevalence of bad weather and had to be beached to avoid obstructing channel; six broke loose from mooring at Fort Point and went to pieces.

Eighty-two and seventy-four hundredths cubic yards of stone were washed off barges near platform February 3, 1882.

REPAIRS OF PLANT.

Four barges were hauled out and repaired; the storage mattress platform was repaired; tug Cynthia was hauled out once, and hull cleaned and boiler and machinery repaired; tug Molyneux hauled out, and hull, boiler, and machinery repaired.

The plant is complete, well adapted to the service, and in excellent condition.

Respectfully,

W. A. HINKLE,
Superintendent.

Col. S. M. MANSFIELD,
United States Engineers.

The following report, to which reference is made in the last Annual Report of this office, page 1328, having been accidentally omitted therefrom, is here inserted as part of the record of the progress of the work:

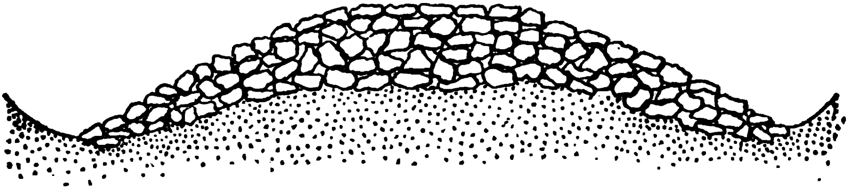
SUPPLEMENTARY REPORT OF SPECIAL BOARD OF ENGINEERS.

ARMY BUILDING,
New York, October 31, 1880.

GENERAL: Your letter of October 21, 1880, refers to this Special Board, which has several times given its views as to various devices for improving the entrance to the harbor of Galveston, Tex., by jetties, a report of Maj. S. M. Mansfield recommending for adoption as his choice of those systems the method pursued in the construction of the jetties at the mouth of the Maas, Holland, in preference to that used in closing New Inlet, North Carolina, and in sinking submerged jetties in Charleston Harbor.

There does not seem to be anything in Major Mansfield's letter to induce this Board to change its views as set forth in their past reports. The information given, however, in reference to the abundance of brush and stone available has an important bearing upon the cost of construction of the jetties. Major Mansfield's experience thus far goes to prove that brush mattresses can be put down in the shoals in mild weather, and that they have kept their place during the storms of August 11 and 12. This trial extends to a length of 100 feet on the north jetty in prolongation of the Bolivar gabionnade, and to 315 feet length in the south jetty, commencing in 6 feet depth of water. No trial seems to have been made with log rafts. We have no preferences in reference to the three methods indicated by sketches B, C, and D in our report of January 7, 1880,* any further than this, that we thought the log base for a brush raft, whether a simple grillage or formed by logs in contact, would hold together better, and could be towed out to its position in the jetty and sunk there more readily and in rougher weather than a brush raft without logs. If the simple brush raft is found sufficient; if it can be made more cheaply without than with a timber base; and, further, if it can be placed in position without much risk of being torn asunder, we think it should be used. No sufficient reasons present themselves against the use of brush mattresses at this locality, for Galveston Bar is formed of Gulf sand and not by river mud, and there will be little settling, except possibly by undermining, at the outer edges. An ordinary enrockment would stand probably as well upon the sands of this shore or bar as in similar positions at the north. Breakwaters in Long Island Sound and along the coast of Massachusetts and Maine are simple enrockments. No bases, either mattresses or grillages, have been required for those constructions, and none would be needed on the Galveston Bar if stone could be delivered as cheaply there (say from $1 to $1.25 per cubic yard) as in northern sections of the country. The wearing of currents or the overfall at the foot of the jetties would merely drop down the stone at the edges thus (Fig. A). But as stone costs $4 and brush only $1 per yard, economy of construction demands the use of the latter as far as possible.

Fig. a.



We do not think it at all necessary, as we have said in previous reports, to follow the system of construction of the Maas jetty in its literal sense. A thick brush mattress sufficiently strong to insure its being held in place until sunk to its position, without risk of being torn to pieces by waves, if covered with stone, can scarcely be dismembered by storms, for it will probably be filled with sand, and the stones sinking into the meshes will hold it together. Further, the Dutch system is very costly. It involves much skilled labor and much exposure in the water. In fact, laying the stones on the side slopes and paving the upper surface would involve careful construction and much delay, so that a contractor who had never done such work could not safely estimate for it except at excessive prices. A system that does not require accuracy of construction, and therefore admits the work to go on even when the sea is a little rough, is preferable, especially in this locality, to the more elaborate and difficult method followed in the Holland jetties.

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* See Annual Report of Chief of Engineers for 1880, page 1221, Part II.

It was to avoid the great losses by delay and various expenditures for plant that in our last report we advised the construction of these jetties by contract. It is presumed that the contractor will push his work for his own interest, and will lose no time that can possibly be availed of for that purpose. We are still of the opinion, therefore, that the contract system in this special case, if it can be carried out, will prove preferable to the system of hired labor. The officer in charge of the improvement can ascertain if there are suitable persons in that vicinity or elsewhere to undertake such work.

In reference to height of jetties we desire to say that the original plans contemplated their submergence throughout the greater portion of their length. It is recommended that they be kept below low-water, with sufficient width to permit of being raised to that level if adjudged necessary. It is not thought that a width of 24 feet at the low-water level will be required, except, perhaps, at their outer ends if prolonged into deep water. It is inferred from the records of observations in reference to the breaking of waves that during gales in the Gulf they will break before reaching 12-foot soundings off the shore. Within those soundings, where only the smaller waves break, there will not be as much exposure as beyond, and the width of jetty need not be so great.

While it may not be necessary to extend the jetties as far as the estimate calls for, or to raise them to the height indicated therein, it seems probable that they must be connected with the shore, if only by an apron formed of mattresses covered with just sufficient stone to hold them in place. The south jetty should be connected with the channel breakwater already constructed; the north jetty with the beach at Bolivar Island. It is quite possible that the gabionnade already formed may be sufficient to prevent the formation of a swash-channel between the inner end of the north jetty and Bolivar Peninsula. In that case the apron will be limited to the space between the inner end of the gabionnade and the beach.

In conclusion, the Board can find no reason in the additional information furnished it for changing methods of construction hitherto recommended, or for adopting the elaborate methods shown by the sections, plans, and profiles of the drawings sent, or for prosecuting the construction by hired labor until the system by contract shall be tried and found a failure. We advise that the jetty be almost, if not wholly, submerged, as originally intended by Major Howell and recommended by this Board, and that it be made wide enough so that at the outer ends beyond the 10-foot curves it can be raised, if necessary, out of water.

In fact the system of construction of the Maas jetty, originated many years since, is very expensive where labor is high. Much cheaper methods of making mattresses have been practiced by our own officers during the past ten years. We think that a simply made mattress, from 50 to 60 feet wide according to depth of water, made with or without logs, that will lay a thickness of from 2 to 3 feet will be sufficient to use from the shore out to a depth of 10 feet; that this mattress should be covered with enough stone to sink it and hold it to the bottom firmly. Afterwards, upon this apron, stone should be thrown along the middle line and be left to take its own slope. By this means a jetty will be formed submerged below the mean low-water line to depths varying from 0 at the shore to say 4 feet at the 10-foot curve. We do not understand the necessity for the expensive plant proposed by Major Mansfield. From our examination of the report it would seem that the preparations therein indicated would admit the construction of both jetties in two years, whereas no such rate of structure will be required to meet the limited appropriations from year to year. We are of opinion that if the system indicated by this Board be carried out the jetties will cost less than the estimate submitted and will be constructed with much less outlay for plant. Of course we would omit the system of piling and railways exhibited on Major Mansfield's plans.

The papers referred to us in connection with this subject are herewith returned.

Respectfully submitted.

Z. B. TOWER,
Colonel of Engineers, Bvt. Maj. Gen.
JOHN NEWTON,
Colonel of Engineers, Bvt. Maj. Gen.
Q. A. GILLMORE,
Lieutenant-Colonel of Engineers, Bvt. Maj. Gen.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

ADDENDUM.

NOVEMBER 19, 1880.

The foregoing report was written before seeing Major Mansfield. From his letter, in connection with two papers prepared by his assistant, Mr. Ripley, and the drawing presented, we inferred that the Holland system as applied at the mouth of the Maas had been adopted by him without much change for the Galveston jetties. From our conversation with him since we learn that he does not intend to follow that method any further than is implied in the use of brush mattresses loaded with sufficient stone to hold them in place, nor to raise the jetties above the level of low-water if sufficient depth over the bar can be gained without doing so. In fact his ideas as to the construction of the jetties seem to be essentially the same as our own. He has further explained the difficulty of getting any one to undertake the work by contract, and the necessity therefore for buying the plant specified, and the reasons for its great cost. We concur with him that the jetties should be pushed forward as fast as possible by the most available means at his command, leaving the contract system to develop itself at Galveston, as elsewhere on the Texas coast, as it may.

Z. B. TOWER,
Colonel of Engineers, Bvt. Maj. Gen.
JOHN NEWTON,
Colonel of Engineers, Bvt. Maj. Gen.
Q. A. GILLMORE,
Lieutenant-Colonel of Engineers, Bvt. Maj. Gen., U. S. A.

O 2.

IMPROVEMENT OF SHIP-CHANNEL IN GALVESTON BAY, TEXAS.

Original estimate (for channel 100 feet wide and 12 feet deep), 1877......	$446,326 42
Appropriated, 1872 to 1882..	446,500 00

The condition of the work at the close of the last fiscal year was as follows:

The channel between Bolivar Channel and Red Fish Bar had a width at bottom of 100 feet and a depth of 12 feet; from the cut at Red Fish Bar, connecting the upper and lower bays, the channel permitted the passage of vessels of 9 feet draught to within a short distance of Houston. The dredging accomplished with the funds appropriated in 1872, 1874, 1875, 1876, and 1878 was—

1. A channel through Red Fish Bar 1,500 feet long, 70 feet wide, and over 7 feet deep.
2. A channel between Bolivar Channel and mouth of San Jacinto River, and through Red Fish Bar, 6,100 feet long, 14½ feet deep, and connecting depths in channel of 9 feet and 8½ feet in the upper and lower bays, and with the private works of improvement at Morgan's Point.
3. The channel between Red Fish Bar and Bolivar Channel, 12 feet deep and 100 feet wide at bottom.

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1882.

The contract with James E. Slaughter, dated July 17, 1881, for dredging a channel in upper Galveston Bay, fixed the date of commencing work September 5, 1881.

For certain reasons the date of commencement was extended (under authority of the Chief of Engineers) to December 15, and then again to February 8, 1882; but it was not until the beginning of March that the apparatus arrived at Galveston, where it was necessary to put it in order and arrange for active operations. Actual operations commenced March 30. Dredging began at the upper end of the government cut, at Red Fish Bar, in 12 feet of water; the extension of dredging following the direct line as staked off according to the permanent beacons in the upper bay.

The plant consists of one dredge-boat (the Charles Forbes), one tug (Continental), and one scow containing four wells with a capacity of 260 yards.

The material excavated and removed from channel under this contract, from March 30 to June 30, 1882, was, in the aggregate, 160,440 cubic yards, and was deposited above one-quarter mile to the westward of the channel cut in 8½ feet of water. The cut is 36 feet wide and 4½ feet deep, in soft mud bottom. Length of line is, approximately, 1,500 feet.

The following is an abstract from my monthly report for May, 1882:

> The contractor's attention having been invited to the fact that his work was progressing in a very unsatisfactory manner, owing to insufficient equipment of plant, he replied on the 22d of May, stating: "My agent had written me that the scow lost would be taken to Morgan City and repaired, as soon as the currents in the river there would permit of towing her there. I have written, by this mail, urging haste." But one dump scow is as yet (June 7) employed upon the work, and the progress making is unsatisfactory in consequence. In accordance with the terms of agreement, the contractor should have a suitable equipment. At the present rate of progress, the work contracted to be completed by the 5th of September, 1882, will not be finished in eighteen months' time.

* * * * * * *

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1883.

Continuing the improvement of channel making 12 feet of water for the navigation of the upper bay.

A project for the expenditure of the appropriation of 1881, $50,000, together with the appropriation of 1882, $94,500, will be made as soon as sufficient data can be collected to aid us in projecting a plan for furthering the improvement. An examination and survey of the line will be made as soon as practicable, and the results thereby obtained will determine future operations after the closing of work under contract with Mr. Slaughter.

Certain conditions were, by the terms of the act of March 3, 1879, imposed upon the Buffalo Bayou Ship-Channel Company, and the acceptance of these conditions by that company was formally agreed to by preamble and resolutions February 14, 1881. (See copy of papers in the last Annual Report of the Chief of Engineers, pages 1334–1340.)

It is not considered that this improvement can be made permanent. With the balance of the estimate of 1877, operations may be continued, under contract during the fiscal year ending June 30, 1884, in improving the channel.

The work is in the collection district of Galveston. The light-houses on or near the line of the work are (1) at Bolivar Point; (2) at Fort Point; (3) at Half Moon Shoal; (4) at Red Fish Bar.

For commercial statistics see report on improvement of entrance to Galveston Harbor; also report on improvement of Buffalo Bayou.

This work is designed to accommodate a large portion of the commerce of the district.

Money statement.

July 1, 1881, amount available		$203,478 74
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$14,792 89	
July 1, 1882, outstanding liabilities	100,219 72	
		115,012 61
July 1, 1882, amount available		88,466 13
Amount appropriated by act passed August 2, 1882		94,500 00
Amount available for fiscal year ending June 30, 1883		182,966 13

O 3.

IMPROVEMENT OF TRINITY RIVER, TEXAS.

Estimate of 1880, dredging bar and removing snags above and below Liberty, and dredging on the bar at the mouth of the Middle Pass	$36,541

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1882.

The contract with Mr. G. L. Long, of Mobile, Ala., entered into July 25, 1881, conditioned that Mr. Long should improve the navigation of the river, from Liberty to its mouth, by cutting out a sand-bar and removing all obstructions as required.

The contractor commenced and completed his work in the month of April. The work accomplished was the dredging of 2,900 cubic yards of sand in making a cut 85 feet wide and 7 feet deep through a bar located about 4 miles below Liberty; also the clearing of the river between the mouth and Liberty by removing thirty-three snags and twenty-five overhanging trees (on 25 miles of river) and the part removal of a wreck (steamboat J. D. Hine) which obstructed the channel about 8 miles below Liberty. The work was satisfactorily done, and contract was closed by the payment of the price agreed on, viz, $7,500, on the 29th of April, 1882.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1883.

The project for expending the balance remaining of the last appropriation, combined with the appropriation of 1882, has not yet been developed. The estimates fully cover whatever cost the necessary works of improvement may be for the time being, but there is no basis for estimating the length of time the cuts made through the bar at the mouth and the bar near Liberty will remain open for navigation, or as to the cost of maintaining the river from its mouth to Liberty in a navigable condition.

Amount appropriated 1878	$10,000
Amount appropriated 1879	2,500
Amount appropriated 1880	4,000
Amount appropriated 1881	10,000
Amount appropriated 1882	8,000
Total 1878-1882	34,500

The available funds might be expended in the fiscal year ending June 30, 1884, in continuing operations—dredging, snagging, &c.—as may be found necessary. Further requisition, in the absence of any river commerce, is not at present demanded.

The work is located in the collection district of Galveston; nearest light-house, Red Fish Bar, Galveston Bay.

Money statement.

July 1, 1881, amount available	$14,569 56
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	7,938 65
July 1, 1882, amount available	6,630 91
Amount appropriated by act passed August 2, 1882	8,000 00
Amount available for fiscal year ending June 30, 1883	14,630 91
Amount (estimated) required for completion of existing project	14,541 00

O 4.

IMPROVEMENT OF BUFFALO BAYOU, TEXAS.

Estimate of 1880, for a channel 100 feet wide and 12 feet deep between Simms' and White Oak Bayou	$385,299 75

For detailed estimates, &c., see last Annual Report of the Chief of Engineers, pages 1343-1347.

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1882.

Under the appropriation of $25,000, act of March 3, 1881, bids were solicited for the improvement of the bayou. The following is an abstract of bids received:

Abstract of proposals for improving Buffalo Bayou, Texas, in response to advertisement dated June 7, 1881, and opened July 6, 1881, by Maj. S. M. Mansfield, Corps of Engineers.

Names of bidders.	Dredging 75,000 cubic yards.	Removing 11.2 miles of trees.	Aggregate.
	Per yard.	*Per mile.*	
1. G. L. Long	$0 21	$199 00	$17,978 80
2. J. J. Atkinson	35	500 00	31,850 00
3. Jas. E. Slaughter	49	193 50	38,917 20

Mr. G. L. Long, of Mobile, Ala., being the lowest responsible bidder, contract was entered into with him September 1, 1881, for doing the work required, viz, removing overhanging trees and dredging shoal places in the bayou near the city of Houston.

Mr. Long commenced in February the cutting of trees along the bayou, and in March completed the work of removing overhanging trees. Eleven and two-tenths miles of bank received attention. In April the work of reducing shoal places began. From April to June 30 there was dredged and removed an amount of material comprising 24,895 cubic yards of snags, logs, stumps, and earth. The work has progressed slowly but satisfactorily, considering the amount of time required to dredge away the stumps, logs, &c., imbedded in the channel of the bayou.

The plant used comprehended one dredge (Osgood's patent), with dipper of 1 cubic yard capacity, and one derrick-boat, with a boom 90 feet long with a clear swing of 75 feet. Another dredge, of large capacity, has just been added to the plant.

PROBABLE OPERATIONS FOR THE YEAR ENDING JUNE 30, 1883.

Completion of work under contract with G. L. Long and continuation of work of improvement by contract, with the funds of the appropriation of 1882.

Amount appropriated 1881	$25,000
Amount appropriated 1882	50,000
Total 1881–1882	75,000

One hundred thousand dollars could be profitably expended in making the improved navigable channel during the fiscal year ending June 30, 1884.

It is in the collection district of Galveston, and the nearest light-houses are those at Clopper's Bar, Red Fish Bar, Bolivar Point, and Fort Point.

Money statement.

July 1, 1881, amount available		$25,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$5,684 18	
July 1, 1882, outstanding liabilities	18,454 84	
		24,139 02
July 1, 1882, amount available		860 98
Amount appropriated by act passed August 2, 1882		50,000 00
Amount available for fiscal year ending June 30, 1883		50,860 98
Amount (estimated) required for completion of existing project		310,299 75
Amount that can be profitably expended in fiscal year ending June 30, 1884.		100,000 00

COMMERCIAL STATISTICS.

[Extract from memorial to Congress of the Houston Cotton Exchange and Board of Trade, dated March 8, 1882.]

* * * * * * *

The city of Houston is a port of delivery of the United States, situated at the head of tide-water on Buffalo Bayou, 50 miles from the Gulf of Mexico.

* * * * * * *

Vessels drawing 9 feet of water now discharge their cargoes at the railroad wharves 6 miles below the city limits. The work of ship-channel improvements now nearly completed by the United States engineers will afford passage for vessels of 12 feet draught to the same point. The work of extending 12-foot navigation from thence to the city of Houston has been commenced under the appropriations made by Congress.

This will afford to the city of Houston navigation for any vessel now able to cross the Galveston outer bar. The present navigation to the city is 6 feet—the business being done by steamboats, lighters, and light-draught sailing vessels.

* * * * * * *

The rapid growth of the lumber trade of the city of Houston warrants the belief that if port facilities are afforded a heavy foreign export trade in lumber can be developed.

The ship-building interest is already of considerable importance. The country along the banks of Buffalo Bayou and the streams emptying into it afford ample supply of oak and other valuable timber, while the Houston lumber market supplies pine of the best quality at very low rates. The interest has thus far been confined to the construction of steamboats, barges, and other light-draught vessels; but with port facilities assured, it is believed that vessels of greater draught will be built.

The situation of Houston in the great cattle district contiguous to the Texas coast warrants the belief that a large export trade in live and slaughtered cattle can be developed if port facilities are guaranteed. This trade is already carried on direct from Buffalo Bayou to Havana.

The total dutiable imports and duties paid at the Galveston custom-house for the year ending June 30, 1881, were:

Dutiable imports	$2,632,731 00
Duties paid	1,772,038 31

The list of imports by Houston importers are exclusively those made in this collection district. A large amount of imports have been made for the same and other Houston importers through the ports of New York and New Orleans. The figures given show that the imports by the Houston importers in 1881 were in excess of $642,000, and duties in excess of $459,200, and in 1882, imports in excess of $776,900, and duties in excess of $568,100, or about 25 per cent. in 1881 of the total imports at the Galveston custom-house, to which this port of delivery is attached, and that about 25 per cent. of the entire amount of the duties collected were paid by Houston importers.

The foreign imports of the city of Houston in 1881 rank as twenty-fourth among the ninety-eight enumerated customs districts of the United States.

O 5.

IMPROVEMENT OF MOUTH OF BRAZOS RIVER, TEXAS.

Estimate for north and south jetties, 1880	$522,890 44
Appropriated, 1880-'82	130,000 00
	392,890 44

For detailed estimates, &c., see last Annual Report of the Chief of Engineers, pages 1349-1355.

At the end of the last fiscal year (June 30, 1881) the north jetty had been extended (mainly on shore) a distance of 742½ feet.

The general thickness (depth of brush work) throughout the line was 3 feet; the width at inner end was 27.8 feet, and gradually widened to 60 feet at the seaward end.

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1882.

Messrs. R. Kanters & Son completed the work of their contract (dated January 19, 1881) the latter part of September.

Under this contract there was placed in north jetty a foundation course of brush mattresses aggregating in length 1,043½ feet. The shore portion commenced with a width of 27.8 feet. The seaward portion averaged 60 feet width throughout. The general height (thickness of mattress and concrete ballast) was 3 feet above the sand bottom.

The project for the expenditure of the funds ($40,000) appropriated by act of March 3, 1881, recommended continuation of work on north jetty by the use of brush mattresses and stone or concrete ballast under contract. The following is an abstract of proposals received in response to advertisement solicited:

Abstract of proposals for improving Brazos River, Texas, in response to advertisement dated June 20, 1881, and opened July 20, 1881, by Maj. S. M. Mansfield, Corps of Engineers.

Names of bidders.	Brush, 4,530 cubic yards.	Stone, 308 cubic yards.	Gravel, 411 cubic yards.	Concrete, 354 cubic yards.	Aggregate.
	Per cu. yd.	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	
1. R Kanters & Son	$4 90	$7 50	$6 00	$8 00	$29,799 00
2. G. L. Long	4 35	No bid.	7 00	7 00	....
3. Wm. W. Burke	4 50	9 00	4 50	9 00	28,192 50

1. Formal; highest bid.

2. Informal; bond incomplete and void; no specified price for stone, and proposals incomplete; bids unsatisfactory.

3. Formal; bids satisfactory; contract recommended.

Some delay was had in awarding the contract; but finally the Secretary of War decided that Mr. G. L. Long's bid was formal, and that the contract should be given to him. In compliance with said decision contract was entered into with Mr. G. L. Long on the 19th of September for doing the work required in continuing construction of the north jetty as specified.

Mr. Long began the work of his contract the end of September. A sufficient quantity of concrete blocks was made in October and November to keep the work of sinking mattresses well in hand, and the first mattress was placed in December.

By the 27th of May, the work under this contract was completed; 1,492 linear feet of jetty was added to the former work; foundation course, 60 feet wide and 2½ feet high; using an amount of material equal to 6,290.84 cubic yards of brush mattresses, and 1,376.86 cubic yards of concrete ballast.

The contract was satisfactorily performed, and the work was left in good condition.

A recent examination and survey was made (chart herewith) of the bar and entrance to the river.

The condition of the shore work (R. Kanters & Son's contract) shows that it has been damaged by the action of the river current, during sudden and heavy rises, in cutting away the channel bank, causing settlement of the channel side of the jetty by partial undermining, deep water hugging the work close down to the point.

A considerable part of the damage was occasioned by the pounding of immense drift logs upon the top of the mattress, in one case grinding the concrete ballast to powder, and then tearing loose the fascines and filling. The storm of the 7th of May slightly increased the damage to this part of the work, by a further cutting away of the bank which induced the very irregular settlement of the line of mattresses. No steps were taken (save a small addition of ballast at a few points) to repair the damage done, because thought unnecessary. This work has served its purpose in extending the shore line north of it gulfward and maintaining it, giving the jetty proper a good shore bearing.

Under date of May 13, 1882, Mr. John M. Picton, assistant engineer, reports:

> It was observed that there was a scour of a foot or more at and beyond the outer end of the jetty May 6, and that the last three mats were placed upon clay bottom in about 12 feet of water at ordinary high-tide.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1883.

Project for the expenditure of the funds of the appropriation of 1882, $50,000, will recommend continuation of jetty construction, by means of brush mattresses and stone or other ballast, under contract.

One hundred thousand dollars may be profitably expended in the fiscal year ending June 30, 1884, in continuing operations in accordance with approved plan.

Commercial statistics, none.

The work may not be susceptible of permanent completion; estimates will vary accordingly.

It is located in the collection district of Galveston, and the nearest light-house is at entrance to Galveston Harbor.

Money statement.

July 1, 1881, amount available	$43,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	40,759 03
July 1, 1882, amount available	2,240 97
Amount appropriated by act passed August 2, 1882	50,000 00
Amount available for fiscal year ending June 30, 1883	52,240 97
Amount (estimated) required for completion of existing project	392,890 44
Amount that can be profitably expended in fiscal year ending June 30, 1884	100,000 00

O 6.

IMPROVEMENT OF PASS CAVALLO INLET TO MATAGORDA BAY, TEXAS.

Estimate, south jetty and groins for shore protection, 1879	$1,039,280
Appropriated, 1876–1882	240,000
Unappropriated balance	799,280

For detailed estimates, &c., see Annual Report of the Chief of Engineers, pages 1258–1260, 1880.

At the beginning of the year, July 1, 1881, the work in position covered an extension to south jetty of 958 linear feet, of which 565 feet was built on shore and the rest in water 1½ to 2 feet depth. The inshore end began with mattresses 25 feet wide over all, and gradually increased in width along the jetty until at the water line it reached 60 feet.

The average thickness on shore was 3 feet, and in water 2¾ feet. The protective covering was a mixed ballast of concrete and stone.

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1882.

The progress of work under contract with Messrs. R. Kanters & Son was impeded by high seas and squally weather, and further delayed by the want of sufficient quantities of stone when most needed. Owing to these circumstances, additional time was granted the contractors (after December 1) in which to complete their contract. By the 18th of February, 1882, the funds available for expenditure under this contract were exhausted and the contract was closed.

The total length of jetty constructed by Messrs. R. Kanters & Son was 1,325 feet, consisting of a foundation course averaging 25 to 60 feet width on shore and full 60 feet width in its seaward portion, and with a second tier and upper course partly built thereon. The work, when inspected prior to acceptance, presented a very stable and finished appearance. The brush work was entirely covered by the stone and concrete ballast. On the shore end the sand had banked up against the sides of the jetty, and in places covered the entire structure. At the gulf end the top of the jetty was at the surface of ordinary high-water. From the outer end of the upper course the riprap sloped down to about 2 feet below the water surface at the end of the second course of mattresses. At the outer end of the first course of mattresses the water was about 12 feet deep. The shore line had advanced with the extension of the jetty; the advance being 400 feet on the north side and 360 feet on the south side of the jetty, with indications of a further shoaling some distance in advance of the outer end of the jetty.

With the appropriation of $60,000 of March 3, 1881, it was intended to continue the work on south jetty. In response to advertisement bids were received, viz:

Abstract of proposals for improving Pass Cavallo, Texas, in response to advertisement dated June 20, 1881, and opened July 20, 1881, by Maj. S. M. Mansfield, Corps of Engineers.

Names of bidders.	Brush, 5,500 cubic yards.	Stone, 430 cubic yards.	Gravel, 485 cubic yards.	Concrete, 540 cubic yards.	Aggregate.
	Per cu. yd.	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	
1. G. L. Long	$4 35	....	$7 00	$7 00	....
2. R. Kanters & Son	8 25	$8 50	6 50	8 50	....

1. Informal; bond incomplete and void; no specified price for stone; bids unsatisfactory.
2. Formal; bids are too high, and therefore unsatisfactory.

In compliance with instructions received from the office of the Chief of Engineers, contract was entered into with Mr. G. L. Long on 19th of September for doing the work required, viz, placing mattresses, in constructing south jetty, and ballasting jetty with concrete or stone.

The contractor, finding that he was unable to complete the work, even if able to commence it, before the 30th of June, asked for an extension of time, promising to use all energy to finish in sixty days from June 30. The authority to grant extension has been received. July 1, 1882, the assistant engineer in charge reports:

Four mattresses are constructed, and will be placed as soon as arrangements for the delivery of material have been perfected. Plenty of stone and brush piled on line of railroad, but the trouble seems to be in transporting it rapidly enough.

The railroad promises ten cars a day for transportation, and a contract (additional) for brush and stone has been entered into with Harrison & Caruthers, of Rockport, to be delivered by the 20th of the month, so material should come in rapidly enough very soon. Contractor has fifty or sixty men employed and will push the work forward to its completion.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1883.

Construction of south jetty to completion of work under contract with G. L. Long, and further work in continuing improvement, after project shall have been prepared, under the appropriation of 1882 giving $60,000 to the work.

I present herewith a report upon this work made July 21, 1881, by assistant engineer Mr. H. C. Ripley, as it contains besides interesting details some valuable observations and suggestions that may lead to a modification of the plan of improvement.

Two hundred thousand dollars may be profitably expended during the fiscal year ending June 30, 1884, in continuing work on jetty.

The work is located in the collection district of Indianola, Tex., and near Matagorda light-house.

Money statement.

July 1, 1881, amount available	$60,000 00
July 1, 1882, outstanding liabilities	55,000 00
July 1, 1882, amount available	5,000 00
Amount appropriated by act passed August 2, 1882	60,000 00
Amount available for fiscal year ending June 30, 1883	65,000 00
Amount (estimated) required for completion of existing project	799,280 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	200,000 00

Table of estimates for foundation course.

NORTH JETTY.

From—	Length.	Width.	Thickness.	Cubic yards.		Remarks.
				Brick.	Stone.	
	Feet.	*Feet.*	*Feet.*			
D to E	14,920	60	2	49,733	16,578	One-quarter stone, three-quarter brush.
E to 12 feet water	4,420	90	......	22,100	7,367	
12 to 18 feet water	2,580	120	......	17,200	5,733	
Total	21,920	......	......	89,033	29,678	

SOUTH JETTY.

From—	Length.	Width.	Thickness.	Brick.	Stone.	Remarks.
1,500 feet from A to 9 feet water.	2,170	60	2	7,233	2,411	
9 to 12 feet water	2,700	90	......	13,500	4,500	
12 to 18 feet water	1,270	120	......	8,467	2,822	
Total	6,140	......	......	29,200	9,733	

ESTIMATED COST.

North jetty.

89,033 cubic yards brush work, at $4.50	$400,648
29,678 cubic yards stone work, at $8	237,414

South jetty.

29,200 cubic yards brush work, at $4.50	$131,400
9,733 cubic yards stone work, at $8	77,864
Total for both jetties	847,326

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, INDIANOLA, TEX.,
Collector's Office, July 5, 1882.

SIR: In response to yours of the 1st instant, I have the honor to inform you that the following is a statement of entrances and clearances at this port during the fiscal year ended June 30, 1882, viz:

FOREIGN TRADE.

Class.	Entered.		Cleared.	
	No.	Tonnage.	No.	Tonnage.
Steam vessels	13	13,213 99	17	17,445 35

COASTING TRADE.

Steam vessels	101	107,397 24	......	....
Sail vessels	13	2,514 81	3	126 45
Grand total	127	123,126 04	20	17,571 80

I beg to state that the tonnage given represents only the tonnage of vessels that report to this office. There are many vessels that arrive and depart from this district that are not required under the law to either enter or clear at the custom-house. For instance, 101 steamers in the coasting trade entered during the year, none of which cleared at the custom-house, although all of them departed. Nearly all vessels engaged in the lumber trade neither enter nor clear.

I am, respectfully,

FRANCIS A. VAUGHAN,
Collector.
By C. W. HARTUP,
Special Deputy.

Maj. S. M. MANSFIELD, U. S. A.

REPORT OF MR. H. C. RIPLEY, ASSISTANT ENGINEER.

GALVESTON, TEX., *July* 21, 1881.

COLONEL: Having made, in accordance with your instructions of the 12th instant, an inspection of the work now being done under contract with Messrs. R. Kanters & Son for the improvement of Pass Cavallo Inlet to Matagorda Bay, Texas, I have the honor to make the following report:

The inclosed sketch shows the condition of the jetty July 14, when the inspection was made.

For convenience of description the jetty may be divided into two parts, the shore work and the water work.

The shore work extends from the inner end to the point B, a distance of 565 feet as measured and already reported by Mr. W. L. Webb, United States assistant engineer. This consists of a single continuous mattress, 25 feet wide at the inner end and 51 feet wide at the point B, and having a thickness of 3¼ feet along the central line and 2¼ feet on the sides. This difference in thickness produces a crowning which is further increased by the preparation of the ground before the work was placed, making the foundation about 18 inches lower on the sides than in the center.

The top surface is to be paved with concrete blocks, laid overlapping each other like the shingles on a roof. About 100 feet of this paving is finished. From the end of the paving to the point B, only a few blocks are placed along the sides to guard against injury in case of high-water, and the whole is mostly covered with sand drifted upon it.

At the point B the water work begins. It consists of mattresses of various dimensions placed as shown in the sketch and covered temporarily with concrete blocks. Where it is necessary to bring the jetty up to the required height a second course of mattresses is placed, as shown at No. 15 and No. 16. On top of the mattresses and extending along the central line of the jetty, and having a width of 26 feet, is placed the *tunrond.*

This consists of *laag wark* paved with concrete blocks placed on edge, so that the blocks come above the stakes and wattling, which are covered with gravel and broken stones. The berm on either side of the *tunrond* is paved between the *wiepen* of the upper grillage of the mattress by lapping the blocks as before described, and by filling in the spaces where the grillage comes with gravel and broken stones.

This forms a perfect protection to the brush-work, and the paving is done in such a manner as to leave little chance of injury from the waves. The *laag wark* consists of brush fascines placed overlapping each other in such a manner as to leave the butts exposed only at the sides. The whole is held in place by rows of stakes driven entirely through the brush both of the *laag wark* and of the mattress below. These stakes, projecting about 6 inches above the brush, permit the wattling to be put on above the brush, thus holding it in place. As the brush settles under the weight of the paving, the stakes and wattling are driven down close to the brush. The gravel and broken stones, which cover them, are not put on until settlement has ceased.

Before the *laag wark* is built, the concrete is all removed from the mattress below, and the sand is all cleared away, so that there shall be a perfect bond between the brush of the mattress and that of the *laag wark.* The butts of the fascines of the *laag wark* are abutted against the longitudinal *wiepen* of the mattress below so as to expose them as little as possible. The protection thus afforded would be complete, were it not for the unevenness of the mattress below, which makes it necessary to build up the *laag wark* higher at some points than at others in order to give the top a uniform grade. The *tunrond* is slightly crowning, being about 8 inches higher in the center than on the sides. It should be mentioned that wherever a second course of mattresses is placed the concrete is just removed from the mattresses below, and the sand cleared away so that the brush of the two courses may come in actual contact.

The jetty attains a width of 60 feet at the inner end of mattress No. 5, a distance from B of 219 feet.

From this point on it has a width of 60 feet.

The work thus far is very satisfactory, and the contractors deserve great praise for the excellent manner in which the work is being executed. * * *

The contractors seem to be making as rapid progress as can be done economically. The water work is right in the breakers, and the water is too shoal to use barges or indeed to float a mattress into position. It is necessary, therefore, to build the mattress in place. This can only be done when the Gulf is smooth, and hence there are frequent and great delays in the extension of the jetty. It is believed, however, that they will complete their contract by the 1st of January, 1882. * * *

The work has hardly progressed sufficiently to decide positively whether the changes which have taken place since its commencement are due to the jetty, or whether they are the result of other causes.

It is quite certain, however, that the jetty has in no way tended to arrest the advance of the shore line, which had already advanced, January 8, 1881, at the site of the jetty since the survey of 1878, a distance of 150 feet.

Since the commencement of the construction, the advance of the shore line has been more rapid, and seems to keep full pace with the extension of the jetty. Between January 8 and July 14 the high-water shore line has advanced 287 feet, measured along the axis of the jetty, and the breakers ahead indicate that the shoaling in advance has been correspondingly great. At the outer end of the jetty there is but one foot of water where the chart of 1878 shows 5¼ feet.

The question naturally arises as to the extent of this advance of shore line, and whether with its advance the bar will advance correspondingly, and thus leave its crest as far from the end of the jetty after two or three years' work as it is at present. There is undoubtedly some danger that this will be the result with the present method and rate of construction. An inspection of the charts of surveys, extending from 1856 to 1878, shows that a somewhat regular series of changes has taken place in the channels and shoals which form and obstruct the entrance to Matagorda Bay.

I shall endeavor to indicate the order of progress of these changes, and, as far as possible, the causes which tend to produce them, from which we may predict future changes under certain circumstances which may be controlled by artificial works.

Assuming that the condition shown by the survey of 1856 is at the beginning of the series of changes about to take place, and we find the pass lying nearly north and south along the eastern shore of the island, with its bar end slightly deflected to the east.

Across the shoals lying east of the pass there are but two well-defined channels, and the larger one of these is shallow and obstructed by shoals.

The survey of 1871, although little more than a reconnaissance, shows a still further deflection of the bar end of the pass to the east and an increased depth over the shoals south of Pelican Island and a movement of the island northward. The survey of 1873 is the last record we have of this series of changes.

The bar end of the pass has become nearly closed. A new channel (Veto Channel) has broken through to the eastward. Elizabeth and Decrow channels have become more defined and deeper, new shoals have formed, and the bar at the sea ends of these channels has moved gulfward, presenting a marked contrast to the condition in 1856.

In 1875 a violent storm changed completely, in the short space of three days, the whole face of the bar, sweeping away the obstructions in the southern prolongation of the pass, and restoring approximately the channels and shoals to their positions in 1856. The next survey was made in 1878. A tracing of this survey and that of 1873 have been made on the same sheet for purposes of comparison. On this can be seen the extent and character of the changes caused by the storm of 1875, and also the initiatory changes of another cycle, which, if not arrested, will progress substantially in the same order as the one just described. Whether it will progress to the same extent depends upon the date and nature of the next cyclone. Upon this tracing is shown two of a number of observations taken in 1873 to determine the force and direction of the littoral current. It will be seen that this current runs in a direction nearly coincident with the 18-foot contour at the points indicated. The arrows indicate the direction of the flow at each position at the times of observations, which were on different days. Observations taken nearer to the peninsula show the direction of the flow to be more nearly coincident with the trend of the coast.

Knowing the existence and direction of this current furnishes an explanation for many of the phenomena here observed. Assuming that its direction is westerly, which is its prevailing direction, it will be seen that the water upon issuing from the bay will be compelled to hug the shore of the island until it acquires sufficient force to overcome the momentum of the Gulf water caused by the littoral current, or until it reaches a point far enough down to escape unopposed. The point of escape will thus be everchanging and dependent upon the relative strength of the littoral current to that of the ebb current. With the littoral current easterly, the discharge from the bay will evidently seek the shortest route to the Gulf.

With the existence of a bar, however, channels will be formed, one to the south end of the pass for the discharge during westerly Gulf currents, and one near Decrow's Point for the discharge during easterly Gulf currents. These channels will determine the points of discharge, but the relative amount escaping through each will be determined by the changing circumstances above mentioned. A preponderance in favor of either channel for any length of time will cause an enlargement of that channel and a corresponding diminution of the other. There are other causes which enter into the determination of the positions of these channels of discharge. Thus, the momentum of the water in discharging from the bay tends to push the channel near Decrow's Point, further south than it would otherwise be. We thus find two channels near the point instead of one (Decrow's Channel and Elizabeth Channel). The first discharge from the bay, before much momentum is acquired, finds an easy exit through Decrow's Channel. Later on, when the momentum becomes great, it finds a more easy exit through Elizabeth Channel. A still greater momentum will tend to carry it still further to the south. The wind also exerts a powerful influence in determining the relative amount of discharge through each channel, and with its changes in force and direction we find the channels changing to adjust themselves to the changing circumstances.

We are now prepared to understand why the bar end of the pass during ordinary weather is continually moving to the east. The waves from the Gulf, upon reaching the bar, are converted into waves of translation, and the particles of sand composing the bar are thus transported from the Gulf side to the pass side of the bar. These are picked up by the outgoing tide and carried to the south end of the pass. The momentum of the ebb water in the pass carries it beyond the point of least resistance to its exit, and hence there is a gradual slackening of the current and a consequent deposit of sand at the lower end of the pass. Especially is this true during southerly winds, which prevail to a great extent during one-third of the year, and during the prevalence of easterly Gulf currents. Any structure, like the one now being built at this point, will tend to increase this deposit, and hence force the channel crossing the bar further to the eastward.

With this change of channel and advance of shore line there will undoubtedly be a corresponding advance of the crest of the bar, as is shown on the chart of 1873, in front of the Veto Channel, where the 12-foot contour is 2,000 feet in advance of the same contour in 1878.

Simultaneous with these changes, which will result in shortening the pass and giving to it an angle which will diminish its discharge, the outlets above will become enlarged or less defined, and the water thus divided can hardly be expected to give any increased depth across the bar. The only hope, in fact, for an increased depth will be in the event of another cyclone, which may not occur for a score of years. It seems essential, therefore, for certain success, that before attempting a completed jetty anywhere across the bar a carpeting of the bar should be effected which will prevent scour and enlargement of channels not favorable to the scheme of improvement.

The position and direction of the south jetty adopted by the Board of Engineers seems to have been well chosen. The direction is such that the discharge will be nearly normal to the direction of the littoral current whichever way it may flow, and the position is such as to favor as little as possible the advance of the bar; for being just at the angle of the coast, the tendency of the littoral current will be to sweep away any deposits which may occur. The line of carpeting should therefore extend from Decrow's Point in a straight line along the shoals east of the pass from D to E; thence deflecting in the arc of a circle until its direction is parallel to the south jetty, and thence in a straight line across the bar. It is believed that this portion should be built before any further extension of the south jetty, so as to arrest any movement of the channel northward, and also to prevent any further enlargement of Decrow or Elizabeth channels, and also to secure the shoals already formed on this line, so as to cheapen as much as possible the cost of building up this jetty in the future, if it be found necessary. The foundation course of the south jetty should then be laid. This much accomplished, it will probably be an easy matter to decide how to proceed to the best advantage in building up the jetties. It is possible that only the south jetty will need to be completed to secure sufficient depth for the present needs of commerce.

The building up of the north jetty from D to E will prevent any further abrasion of the island along the face of the pass, if my conception of the cause of this abrasion be correct.

It is believed that the cause of the westward movement of the pass is due to the deposit of sand on the east side of the pass, caused by the waves rolling over the bar as before described, thus tending to narrow the pass by accretions on its eastern side only, while the effort of the ebb-current to restore its width acts upon both sides, resulting in a westward movement of the pass. The greater compactness of the older formation will impose a greater resistance to the scour on the west than on the east side of the pass; but whatever progress is made in this direction is practically permanent, and hence any storm which greatly enlarges the pass produces a corresponding westward movement. If, therefore, a wall be built on the east side of the pass which will prevent the sand from coming into the pass, whatever enlargement occurs during extraordinary discharges will be permanent, and further abrasion of the island will cease.

Fears have been expressed that the closure of Decrow and Elizabeth channels, and the building up of the shoals east of the pass, would so much obstruct the admission of flood-water as to sensibly diminish the scouring force of the ebb-current. It is believed, however, that the same opening which will allow the ebb-water to escape is sufficient for the admission of flood-water. For since the duration of high-water is about twice as great as the duration of low-water, there will be twice the length of time for filling the bay that there is for emptying it, and hence the bay will become filled long before the time for the ebbing to begin. The accompanying tracing, from the tide and velocity record at Galveston, very clearly illustrates the point in question.

I am indebted to Mr. R. B. Talfor, United States assistant engineer, for the preparation of the tracings and for the estimates accompanying this report. The estimates are for a foundation course for both jetties 2 feet in thickness, and varying in width from 60 to 120 feet.

The estimates are as follows:

For the north jetty	$638,062
For the south jetty	209,264
Total for both jetties	847,326

Very respectfully, your obedient servant,

H. C. RIPLEY,
United States Assistant Engineer.

Bvt. Lieut. Col. S. M. MANSFIELD,
Major, Corps of Engineers, U. S. A.

O 7.

IMPROVEMENT OF ARANSAS PASS AND BAY UP TO ROCKPORT AND CORPUS CHRISTI, TEXAS.

Estimate for jetties, groins, shore protection, &c., 1879	$759,185 00
Estimate for dredging, &c., in the bay, 1879	441,537 75
	1,200,722 75
Appropriated, 1879-'82	280,000 00
Unappropriated balance	920,722 75

At the close of the last fiscal year, June 30, 1881, the works of improvement in position at the pass were as follows:

1. Breakwater along channel face of Mustang Island, 870 feet long.
2. Seven groin jetties on the west side of the pass, protecting head of Mustang Island up to and beyond Turtle Cove.
3. Sand fences on Mustang and Saint Joseph islands, 4,950 running feet on Mustang Island and 10,560 running feet on Saint Joseph Island.
4. Foundation course of south jetty, 2,200 linear feet.

All work consisted of brush mattress work and stone ballast.

PROGRESS MADE DURING YEAR ENDING JUNE 30, 1882.

The project for the expenditure of the funds ($80,000) appropriated by act of March 3, 1881, proposed to continue work on south jetty; labor to be hired; incidentals to be purchased in open market, and brush, stone, and cordage to be procured by contract (if possible) after due advertising.

The following is an abstract of bids received for furnishing materials:

Abstract of proposals for furnishing material (Aransas Pass and Bay), in response to advertisement dated June 7, 1881, by Maj. S. M. Mansfield, Corps of Engineers.

Bidders.	Marline, 2,250 pounds.	Brush, 4,500 cords.	Stone, 4,500 tons.	
	Per lb.	*Per cord.*	*Per ton.*	
1. John I. Caruthers	$0.16	$3.60		
2. William Anderson			$4.00	300 tons per month.
3. F. Brunner		3.35		

1. Contract for marline not recommended.
2 Bid rejected; monthly delivery inadequate.
3. Contract for brush recommended.

The contract for brush was awarded Mr. F. Brunner. Articles of agreement bearing date August 16, 1881. Contract was closed by a final payment made March 8, 1882, covering a total delivery of 4,517.55 cords.

In accordance with the terms of letter of July 20, 1881, and with the approval of the Chief of Engineers, a bid of $3.95 per ton for stone, made by Mr. C. M. Holden, of Fulton, Tex., was accepted. The stone furnished by Mr. Holden was ample for the work in hand, and the delivery was satisfactory.

Cordage required was furnished by purchase in open market.

Unfavorable weather was experienced in July, August, October, November, and February, and the other months of the year, excepting September, were only partly favorable for doing the work required with our insufficient plant.

As accomplished, the work consisted of making good connection between the shore and inner end of south jetty; the extension of the jetty seaward; the widening of its base, and building it up to a higher level by successive superposed courses; and, finally, when funds became low, by securing the line with a thorough ballast of rock, obtained and distributed for that purpose. In addition to construction work on south jetty, it became necessary at times to preserve the inner revetment groins. This covered the placing of mattresses and stones in extending the work or building it up, wherever found imperatively necessary, either upon the revetment or a particular groin. All work was done by hired labor from the beginning of the year until May 20, 1882, when funds became exhausted.

Sundry inexpensive repairs were made during the year to the brush and mattress platform and the tug and other boats. The tug Molyneux became disabled December 23 by the breaking of her shoe, &c., and, requiring other repairs (after severe service), she was withdrawn from the work and brought to Galveston. Under authority she received a thorough overhauling and was put in good repair.

After May 20 an agent of the government was left in charge of the property at the pass, which was either carefully stored or left in safe position.

A recent survey (chart herewith) has been made, and in connection therewith I submit the special report of the assistant engineer, Mr. W. L. Webb, who has had charge of this improvement during the year.

Owing to unexpected difficulty in securing the head of Mustang Island from erosion, and consequent movement of the pass to the westward, less progress was made with the jetty than it was expected would be. It is now believed that the pass is secure in its present position, and we may therefore expect to place the whole of the next appropriation into the construction of the jetty with a reasonable hope of completing it to such extent as will warrant us in predicting a largely improved channel over the bar. This estimate is predicated upon results already obtained from the jetty in its incomplete state.

As the improvement here also contemplates work in the bay, to facilitate navigation up to Rockport and Corpus Christi, and as we have already quite as much water on the bar as can be carried through these interior passages, and as we have the assurance of a largely improved bar next season with the expenditure of the funds appropriated by this Congress to make this fine harbor accessible to deep-draught ocean vessels, it is time to turn our attention to the improvement of the bay.

By reference to the Report of the Chief of Engineers for 1879, it will be seen an estimate of $441,537.75 was submitted to improve by dredging the channels from the deep water of the harbor—one to the deep water of Corpus Christi Bay, the other to the deep water of Aransas Bay—to accommodate shipping to the wharves of Corpus Christi and Rockport.

The estimates in detail are as follows:

FOR THE PASS.

North jetty	$344,000
South jetty	293,950
Groins	26,400
Shore protection	24,000
Contingencies, 10 per cent	68,835
Planting trees	2,000
	759,185

FOR THE BAY.

Major Howell's report, 1879		$441,537 75
		1,200,722 75
Appropriated to 1881	$180,000	
Appropriated, 1882	100,000	
		280,000 00
Unappropriated balance		920,722 75

It is thought the estimate for the pass is much in excess of the actual requirements and may be reduced $350,000, if it be found, as I think it will, that a north jetty will not be required.

The importance of improving this harbor on the western portion of the Gulf coast cannot be questioned. A harbor of refuge will be supplied to a long extent of dangerous coast. An important railway line is now in operation from Corpus Christi through Leredo, and into the heart of Mexico, making rapid strides toward the capital; while other roads are projected to this point and are only waiting the consumation of the improvements to begin actual construction. A line of steamships has been established between England and the port, bringing railroad supplies and receiving products of Mexican mines for return cargoes. I feel justified, therefore, in increasing my requisition of funds for the next fiscal year to $400,000.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1883.

Continuing improvement of the pass by means of jetties constructed of brush mattress work and stone ballast to the limit of the sum appropriated for the year ending June 30, 1883, $100,000.

Four hundred thousand dollars could be very profitably expended in the fiscal year ending June 30, 1884, in constructing jetties at the pass and improving interior channels.

The work is located in the collection district of Corpus Christi, and the nearest light-house at Aransas Pass.

Money statement.

July 1, 1881, amount available		$80,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$79,251 47	
July 1, 1882, outstanding liabilities	300 00	
		79,551 47
July 1, 1882, amount available		448 53
Amount appropriated by act passed August 2, 1882		100,000 00
Amount available for fiscal year ending June 30, 1883		100,448 53
Amount (estimated) required for completion of existing project		920,722 75
Amount that can be profitably expended in fiscal year ending June 30, 1884		400,000 00

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, CORPUS CHRISTI, TEXAS,
Collector's Office, July 11, 1882.

SIR: In reply to your letter of inquiry, I beg leave to state that the entrances and clearances of vessels in this district, through Aransas Pass, for the year ending June 30, 1882, have been as follows:

FOREIGN TRADE.

Class.	Entered.		Cleared.	
	Number.	Tons.	Number.	Tons.
Steam vessels	5	7, 178	2	2, 976
Sail vessels	2	1, 041	2	652
COASTING TRADE.				
Steam vessels	81	94, 133	66	78, 126
Sail vessels	40	11, 809	29	9, 755
Grand total	128	114, 161	99	91, 509

This does not by any means represent the business done through the pass, for the inspector at this port has in the past year boarded 299 vessels which arrived at Corpus Christi, while the railroad company has received at Aransas Pass the cargoes of 86 vessels, amounting to 43,655 tons of freight.

There have also been very large receipts of freight (lumber) coastwise in vessels which are not required to enter and clear at the custom-house.

It is safe to say that the business done through Aransas Pass during the past year is at least three times as much as for any previous year.

But for the improved condition of the bar, caused, in my opinion, by the work you have done there, this great increase of trade would have been impossible.

There is every reason to believe that increased business, both domestic and foreign, will accrue to this section of the country from the continuation of the work of deepening the bar. Already a line of English steamers is put on from Liverpool, England, to this place.

Very respectfully,

SAM M. JOHNSON,
Collector.

Maj. S. M. MANSFIELD,
Corps of Engineers, U. S. A.

LETTER OF THE COLEMAN-FULTON PASTURE COMPANY.

OFFICE OF THE COLEMAN-FULTON PASTURE COMPANY,
Rockport, Tex., June 28, 1882.

DEAR SIR: In accordance with your request, contained in your letter 22d instant, I beg to state that the amount of business done over our wharf for the year ending this date is as follows:

Total number beeves shipped	4,765
Total number calves shipped	484
Total number barrels freight received and shipped	45,000
Total number bales of cotton	364
Total number barrels freight received and shipped at Fulton, estimated	20,000

Cotton raising in this section is in its infancy. Previous to this year past only 30 bales passed over our wharf, but the experiment has proved a success, and I predict that in the near future thousands instead of hundreds of bales of cotton can be reported as having been shipped yearly from here. In the counties west of here the amount of cotton planted is greatly in excess of last year.

Yours very truly,

SAM J. SEYMOUR,
Secretary and Treasurer Coleman-Fulton Pasture Company.

Col. S. M. MANSFIELD.

REPORT OF MR. W. L. WEBB, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 11, 1882.

SIR: In obedience to your orders I left Galveston for Aransas Pass on April 19, 1881, arrived on the 20th, and took charge of the work on the 23d, relieving Mr. Robert Herman, assistant engineer. The works were in the following stage of progress:

Harbor Island jetty and groins Nos. 1, 2, and 5 were finished. Groins Nos. 3, 3½, and 4 had been built up to the surface, but had afterwards settled. The breakwater between groins Nos. 2 and 3 had also settled. The foundation course of mats for the south jetty had been placed for a distance of 880 feet, of which 44 feet were 29 feet wide, 489 feet were 32 feet wide, 59 feet were 44 feet wide, and 288 feet were 56 feet wide, the depth of water at the east end being about 9 feet at mean low-tide.

The following are the additions to these works:

To groin No. 3.—Four mats, 2 by 32 by 56 feet.

To groin No. 3½.—One mat, 2 by 32 by 56 feet, which forms a part of the revetment between groins Nos. 3 and 3½.

To groin No. 4.—Two mats, 2 by 32 by 56 feet, and 2 by 50 by 70 feet.

To south jetty.—The foundation course has been extended 1,635 feet east, of which 1,579 feet are 56 feet wide, and 56 feet are 32 feet wide, and 305 feet west end 15 feet wide. The second course of mattresses is 32 feet wide and extends to within 750 feet of the east end of the first course. The jetty has been raised to the surface of the water at high-tide from the shore to 891 feet east of the original west end of the jetty, a total distance of 1,196 feet.

To breakwater between groins Nos. 2 *and* 3.—The foundation course of mats has been widened 32 feet, making it 60 feet wide, and it has been raised to the surface at high-tide for 350 feet by a second course of mats 15 feet wide.

Revetment of Mustang Island.—The head of Mustang Island from 75 feet northwest of groin No. 3 to groin No. 4 has been reveted by one tier of mattresses 2 feet thick, of irregular width, which extends 30 feet to 80 feet into the water and 30 feet to 75 feet back on shore.

A sketch accompanies this report, showing a plan and section of the groins, breakwater, and revetment, and another sketch shows the plan and sections of the south jetty.

The mattresses are made on the Dutch plan, similar to those used at Galveston, and the details of construction are the same. Live oak and sweet bay brush was used, of which very strong though not compact mattress can be made, the oak brush especially being very tough and elastic. The Spanish windlass, which may be described as a round wooden beam of any convenient diameter and length, say 6 inches to 8 inches diameter and 10 feet to 15 feet long, with 2-inch auger holes at intervals of 2 feet for the insertion of handspikes, was used at first to compress the mattresses. The elasticity of the brush was first broken by compression to the full strength of the quilting-ropes, which were then loosened, passed around the upper grillage, and drawn tight with the windlass. The lever used at Galveston was afterwards adopted as doing better work and being more economical.

In towing the mats, one end was launched on to the stern of the barge and made fast, which made it tow much easier. The mats were held in place while being sunk by lines to anchors and to the stone-barge. Only one barge was used in sinking, no lines for holding the mats at the surface of the water being used.

The elevation of mean low-tide was determined by averaging a number of observations of low-tide, and this determination was verified by comparison with the gauge at Galveston of observations for thirty-seven days during April and May, 1882. The average of the low-tides gave a reading of 0.6 foot for the elevation of mean low-tide on the Aransas gauge. Comparison with the Galveston gauge gave 0.619 foot.

Two bench-marks were established:

No. 1. A horizontal cut, marked B. M., on the foundation block at the northeast corner of the engineer office; elevation, 8.52 feet above mean low-tide.

No. 2. Top of base-board at the northwest corner of the life-saving station; elevation, 8.87 feet above mean low-tide.

The groins built out into the channel from the head of Mustang Island to prevent the cutting away of the island, have proven a complete failure. Located on the concave bank of the pass where the current impinges against the bank, they cause such strong eddies that they are themselves undermined and sink, leaving no protection for the island, which is not only undermined by the pass current, but also by the eddies which the groins have caused. The island is of beach formation or quicksand, and is very easily scoured.

Nos. 1 and 3 are the only groins which now extend to near the surface. Groin 3 has sunk repeatedly, but stood the "northers" of the past winter without settling. On November 24, groin No. 4 sank 12 feet in three hours, and the bank caved in between groins 3½ and 4 for 50 feet back from the former shore. On December 17, groin 3½ sank and the bank caved in to within 75 feet of groin 3, and 50 feet back from the shore line; and on December 21, part of the breakwater between groins 2 and 3 sank. As soon as the breakwater sank the water from the cove flowed out through the opening and broke the eddy, and very probably saved groin 3. The flow of the tide in and out through this place prevents eddies, and will probably prevent groin 3 from settling.

Previous to the sinking of groin 3½ a carpeting of mattresses had been placed between groins 3 and 3½, extending 56 feet into the water and 50 feet back on shore, which, owing to the scarcity of stone, was not fully ballasted. The caving was apparently stopped by the weight of a set of mattress-ways which had been constructed on the revetment, and which were supported on stone piers. The caving advanced rapidly until these piers were reached when it stopped abruptly at that point, but cut a pocket 15 feet further behind it.

On April 20, the breakwater between groins 3½ and 4 sank, and the bank caved for 15 feet behind the mats. The revetment was well loaded with stone, and was thought to be secure. The tide was flooding and the pass smooth.

No unusual conditions were observed previous to these settlements, which came without warning and at any condition of wind and tide. There was no gradual subsidence but a sudden giving way of the foundation, letting the groin fall. The appearance was that of a caving bank. There was no perceptible current in any one direction, though the water boiled and foamed in numerous eddies; 3 feet to 6 feet of the top tier of mats would begin to move and suddenly sink into the water, bending at nearly right angles to the remaining portion. The bank for 50 feet back was perceptibly shaken by the falling of these masses.

In the following table are given the lengths and widths of foundations, the tiers of mattresses, and the total subsidence of each section of the groins:

	Foundation.		Tiers of mattresses.	Subsidence.
	Distance from inshore end.	Width.		
	Feet.	*Feet.*		*Feet.*
Harbor Island jetty	0 to 180	32	1	Not surveyed.
	180 to 200	82	1	Do.
	200 to 365	32	2	Do.
	365 to 405	33	3	Do.
	405 to 450	41	3 to 1	Do.
Groin No. 1	0 to 100	11	1	1
	100 to 135	44	4	19
	135 to 165	62	4 to 3	25
	165 to 195	41	1	10
	195 to 248	53	1	10
Groin No. 2	0 to 40	11	1	10
	40 to 60	29	2	17
	60 to 120	44	3 to 1	18
Groin No. 3	20 to 40	11	1	6 to 12
	40 to 60	Breakwater.	3	12 to 15
	60 to 203	44	4 to 5	15 to 0
Groin No. 3½	0 to 105	Revetment..	3	6
Groin No. 4	0 to 70	Revetment..	1	12
	70 to 105	33	4	8
	105 to 195	44	5 to 1	8 to 5
Groin No. 5	0 to 240	32	2	0

The present revetment is made of live oak and bay brush, of which a very close and compact mattress cannot be made, and the revetment may fail on account of being too open. There is no doubt but that a revetment made of small, straight, pliable brush will secure the island against any further erosion.

EFFECT OF THE SOUTH JETTY.

The south jetty has caused a channel to open through the shoal to the north of the wreck of the Mary. This scour began with the strong ebb currents caused by the early "northers" of last winter, and vessels began using the channel about January 15.

Extensive deposits are being made to the north and south of the shore end of the jetty, which will protect the jetty from heavy seas from any direction. At the time of the survey the shoal south of the portion of the jetty raised above the water surface had less than 1 foot of water on it. The low-tide shore line has since been reported to have advanced out to opposite the end of the raised portion. On the north there has been considerable shoaling, as shown by the advance of the 6-foot contour.

The shore line has advanced slightly on the south side of the jetty, and has receded about the same distance on the north side. A considerable advance of the shore line on both sides of the jetty is expected during the summer.

The littoral currents of the Gulf are apparently due entirely to wind. I have taken no observations to determine their velocity, but the evidence of pilots and masters of vessels plying along the coast give the highest velocity, storms excepted, at about 2 miles per hour. For the greater part of the past year the current has been running towards the north, the effect of the prevailing southeast wind. One effect of this current and the winds that cause it is to constantly move the bar channel towards the north, both by the direct effect of the wind on the past current and by the pouring in of the Gulf water over the south bank, which causes the north bank to be cut away and the south bank to build up by the deposit from the Gulf water. During this action the bar gets longer, more particularly from deposits on the inshore side, and the channel becomes less defined. This action continues through one or more seasons until some unusually strong ebb-current cuts a new channel to the southward, which soon becomes the main channel; the northeast channel closes up, and the new channel begins moving towards the north, to be in turn closed up and replaced by one farther south.

Waves from the Gulf, caused by easterly or southerly winds, pour over the shoal, extending from the Mary (wreck) to Mustang Island, and heap up the water in the basin between the south jetty and the shoal, causing a strong current to the north across the jetty when it is not raised above water, which is greatest around the end of the raised portion, and diminishes toward the outer end when it flows parallel to the jetty. With average to high-tide and a southeast breeze this current flows to the north with a velocity of 2 to 4 miles per hour. With a strong northeast breeze it flows in the opposite direction with an equal velocity. The effects of these currents are:

1st. To cut a channel 15 feet to 18 feet deep on each side of the jetty at the edge of the foundation tier of mattresses by the overfall over the jetty.

2d. Their varying velocity and direction cause the pass current to approach or recede from the jetty, preventing the formation of a well-defined channel, except from near the Mary outward, and causing the crest of the bar to be located 600 feet north from the Mary, instead of about 700 feet southeast of the Mary, its normal position. These currents also drop into the channel large quantities of sediment which they have taken from the shoals over which they pass to reach the channel.

The remedy for this changing and shoaling of the channel is obviously to raise the jetty to the surface and thus prevent cross currents. No permanent deepening of this part of the channel may be expected so long as the present conditions exist.

I suggest that the extension of the jetty seaward from the wreck of the Mary be made on a curve to the north, instead of straight out on the present line, and that the cross-section be similar to that of Galveston jetty. The improvement of the harbor of Swinemünde, Prussia (see Report of Chief of Engineers for 1881, Part II, page 1060), is an example of the successful application of curved jetties to harbor improvement. The radius of the curve should be about 7,000 feet; the width of the foundation tier of mats should be increased to 90 feet. Should the work be pushed rapidly, without giving time for scour around the end of the work, three tiers of mattresses will reach the surface.

Very respectfully, your obedient servant,

W. L. WEBB,
United States Assistant Engineer.

Bvt. Lieut. Col. S. M. MANSFIELD,
Major of Engineers, U. S. A.

O 8.

IMPROVEMENT OF HARBOR AT BRAZOS SANTIAGO, TEXAS.

Estimate for jetties and interior dam, 1881	$678,084 50
Appropriated 1880-'82	*160,000 00
Unappropriated balance	518,084 50

For estimates, &c., in detail, see Report of the Chief of Engineers, 1881, pages 1366-1373.

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1882.

The project for the expenditure of the funds available, $100,000, of the appropriations of 1880 and 1881, was, after recommendation of the

---

*Appropriation of 1878, $6,000, was applied to removing a wreck; is not included in above total amount.

Board of Engineers for Fortifications and for River and Harbor Improvements, approved, viz, to use the funds in constructing the south jetty, work to be done by contract, after advertising in the usual manner.

In response to advertisement, the following bids were received:

Abstract of proposals for improving harbor at Brazos Santiago, Texas, received in response to advertisement dated September 26, 1881, *and opened November* 1, 1881.

Names of bidders.	Brush, 16,000 cubic yards.	Ballast, 7,000 tons.	Aggregate.
	Per yd.	*Per ton.*	
1. G. L. Long*	$3 70	$4 90	$93, 500
2. R. Kanters & Son	6 00	8 50	155, 500
3. A. M. Shannon & Co	3 33	5 81	93, 950
4. S. N. Kimball	5 95	9 00	158, 200

*Lowest bidder.

Contract was entered into with Mr. G. L. Long, of Mobile, Ala., January 2, 1882, for building the jetty required, viz, on the south side of channel, extending from the head of Brazos Island to the 12-foot contour across the bar, a distance of 3,630 feet.

The line of work was surveyed and laid out in the month of March, 1882. The beginning of work under contract did not commence until the middle of April; the first mattress-piece, 90 by 60 by 1.9 feet, placed, located the initial point of the jetty on the beach at high-water mark. At the close of the year the following work had been placed by the contractor, and being in accordance with the specifications governing the work, it was duly accepted:

One layer of brush-work (thirteen mattress-pieces) 60 feet wide, 495 feet long, and with the brick ballast 2½ feet high above the sand bottom. The quantity of material used was: Brush, 6,928.25 cubic yards; ballast, 2,074.19 tons. The work has been satisfactorily done.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1883.

The construction of the south jetty to the exhaustion of the funds applicable to the work under contract with Mr. G. L. Long to be completed November 1, 1882.

With the funds of the appropriation of 1882, $60,000, the south jetty will be entirely completed as projected, if contract prices come within the limit of the estimate for the work.

Proposals for doing the work, as usual, will be invited by advertisement.

A chart of the harbor, embracing the waters of the Laguna Madre as far as Point Isabel, was made in April by assistant engineer, Mr. H. C. Ripley, and together with his report is submitted herewith.

In continuing work of improvement at this point, $200,000 could be profitably expended in constructing south jetty and interior dam during the fiscal year ending June 30, 1884.

It is located in the collection district of Brownsville, Tex., and the nearest light Brazos Island light beacon.

Money statement.

July 1, 1881, amount available		$100,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$5,005 33	
July 1, 1882, outstanding liabilities	91,783 92	
		96,789 25
July 1, 1882, amount available		3,210 75
Amount appropriated by act passed August 2, 1882		60,000 00
Amount available for fiscal year ending June 30, 1883		63,210 75
Amount (estimated) required for completion of existing project		518,084 50
Amount that can be profitably expended in fiscal year ending June 30, 1884.		200,000 00

COMMERCIAL STATISTICS,
CUSTOM-HOUSE, BROWNSVILLE, TEX.,
Collector's Office, July 15, 1882.

SIR: In reply to your request of the 1st instant, I have the honor to furnish you with the following statement of the business of this district for the year ending June 30, passing through the port of Brazos Santiago, viz:

Vessels arrived, 71	tons	58,812
Vessels departed, 72	do	59,716
Value of foreign cargo		$595,235
Value of domestic cargo		3,813 317

I am, sir, very respectfully,

J. L. HAYNES,
Collector.

Col. S. M. MANSFIELD,
Major of Engineers, U. S. A.

SURVEY FROM BRAZOS DE SANTIAGO THROUGH LAGUNA MADRE TO POINT ISABEL, TEXAS.

REPORT OF MR. H. C. RIPLEY, ASSISTANT ENGINEER.

GALVESTON, TEX., *April* 19, 1882.

COLONEL: In accordance with your verbal instructions to proceed to Brazos Santiago, Tex., and lay off the line of the south jetty to enable the contractor to commence its construction, and to make a survey "from Brazos de Santiago through Laguna Madre to Point Isabel, Tex., to ascertain the cost and practicability of a deep-water channel from the anchorage at Brazos de Santiago to the railroad wharf at Point Isabel," I have the honor to make the following report:

Accompanied by Mr. J. M. Picton, United States assistant engineer, as my assistant, I left Galveston on the 18th, and returned on the 25th of March, having accomplished the object of the trip.

In order to properly locate the line of the jetty it was necessary to make a survey of the pass and bar, so that the survey was tolerably complete from Point Isabel to the Gulf.

The soundings on the bar do not cover the shoals so completely as is desirable, but it was quite impossible to obtain soundings on the shoals on account of the almost continual prevalence of breakers and the limited time occupied by the survey.

On the north side of the pass there is a continual line of breakers extending from the shore of Padre Island to the crest of the bar, while on the south side there is a succession of breakers and spaces without them, extending from the shore of Brazos Island to the crest of the bar, showing that there is a succession of channels and ridges running nearly parallel to the shore line, trending to the southward.

The accompanying tracing shows the result of the survey, and also the location of the proposed jetties and dam.

The proposed south jetty, which is the one first to be constructed, extends from the high-tide shore line of Brazos Island to the 12-foot contour across the bar. Its outer portion has a length of 3,025 feet, and has a direction N. 88° 33′ E., is normal to the 18-foot contour outside the bar, and hence probably normal to the direction of the littoral current of the Gulf at that point, and if prolonged westward would be nearly tangent to the north point of Brazos Island. Its inner end is normal to the shore line, and is connected with the outer portion by 3 chords, of 310 feet each, of the arcs of a circle whose radius is 990 feet. Its total length is 3,955 feet.

The proposed north jetty, as shown, has a length of 4,000 feet, and gives an opening between the jetties of 1,500 feet, equal to the narrowest part of the gorge between Padre and Brazos islands. Its location, however, may need modification when the effects due to the construction of the south jetty and dam shall have been determined.

The proposed dam extends from Point Isabel to the head of Brazos Island, and has a total length of 17,040 feet. Starting at the point *e*, it extends to *f* 2,760 feet, on a curve whose radius is 3,550 feet; from *f* to *g*, 12,290 feet; and from *g* to *h*, 1,990 feet on a tangent. This tangent is coincident with the western prolongation of the outer portion of the south jetty. The necessity of this dam as an adjunct to the permanent improvement of the harbor and entrance is fully set forth in my report to you dated June 2, 1881. (Page 1367, last report.)

Its location as here shown is modified somewhat from that given in the report above referred to, in order to make it conform to the actual location of the proposed south jetty and to more perfectly accomplish the desired result of extending the deep water of the pass to the wharf at Point Isabel. Its location is such that the flow of water through the gorge will be facilitated as much as possible, and its power of erosion thus preserved to do effective work upon the bar and in channel extension.

It is somewhat problematical as to the extent of the scour which will result from the construction of this dam; but it is believed, however, that unless a more refractory material is encountered lower down than is found at the surface, the deep water will be extended well-nigh, if not quite, to the wharf at Point Isabel. Any deficiency in depth of channel can be supplied by dredging at a moderate expense. The actual cost, in the nature of the case, it is quite impossibe to estimate; but it is believed that the estimate of cost for the construction of the dam is amply sufficient to cover any reasonable contingencies in the matter of deficiency of depth.

The estimate of cost, already submitted, of constructing this dam, namely, $327,979, might be materially reduced with our present knowledge of prices and facilities for work at that point, notwithstanding that the length of the dam, by its change of location, has been somewhat increased. But in view of the considerations above, it is deemed advisable to retain the original estimate. It should be remembered, however, that this immense outlay is not to be incurred solely for the purpose of extending deep water to Point Isabel, but that the dam is to form an important factor in the permanent improvement of the entrance to the harbor.

Very respectfully, your obedient servant,

H. C. RIPLEY,
United States Assistant Engineer.

Col. S. M. MANSFIELD,
Major of Engineers.

SPECIAL REPORT OF MAJOR S. M. MANSFIELD, CORPS OF ENGINEERS, UPON IMPROVEMENT OF THE HARBOR AT BRAZOS SANTIAGO, TEXAS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., January 6, 1881.

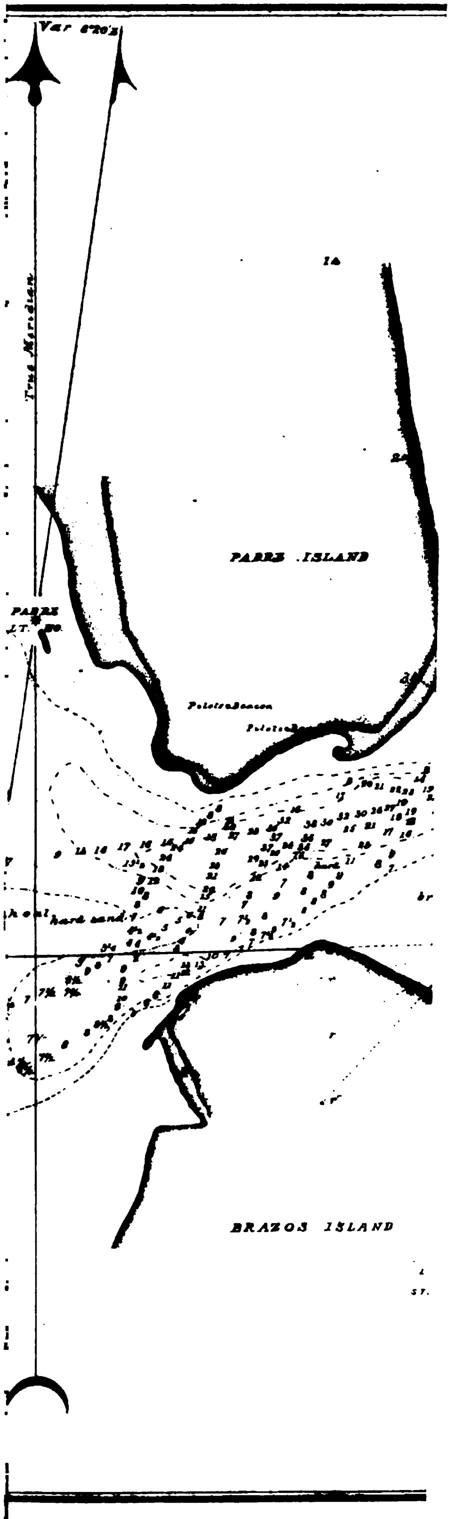
GENERAL: I have the honor to submit the following report upon an estimate for improving the harbor at Brazos Santiago, Tex.:

In my annual report submitted to you in July last I gave a summary of the views of Lieut. (now Capt.) H. M. Adams, Corps of Engineers, upon his survey and examination of the harbor and pass of Brazos Santiago, Tex., made in 1871, January 28 to March 13. The report submitting plan and estimates for improvement was rendered April 7, 1871, and may be found in the Report of the Chief of Engineers, 1871, page 544.

From this report it appears:

> The entrance to the harbor, like the entrance to all harbors on the coast of Texas, is obstructed by a bar not extending directly across the mouth of the pass, but from points of the shore above and below, in a curved form, out to sea. The bar is situated so as to be entirely exposed to the action of heavy storms. It is composed of a quicksand formation, acted upon with extraordinary facility by water. The channel across the bar is constantly shifting, and cannot be depended on from day to day. The depth of water at the time of the examination was 7 feet at high-tide.

The greatest depth of water in the harbor is 27 feet.


Var 6°20'E
True Meridian
14
24
PADRE ISLAND
PADRE LT. HO.
Pointer Beacon
shoal
hard sand
hard
br
BRAZOS ISLAND

The improvement desired is a deeper channel across the bar.

Captain McClellan, in 1853, in a report to the Chief of Engineers, said:

> I regard it as impossible to improve the bar by dredging, scraping, or any similar means.

Captain Adams held the same opinion, and says:

> The only possible application of dikes in this case would be to prolong the walls of the outlet until they reached a point very near the present position of the bar, in order to concentrate upon one spot the whole action of whatever outward current there might be. The immediate effect of this might be favorable. The ultimate effect would undoubtedly be the formation of a new bar outside the present one, and that at no distant period.
>
> The foundation of the dike would be in quicksand, and the difficulties of construction would be very great.

Captain Adams projects a single jetty (training wall) 3,500 feet in length on the south side of the pass, at an estimated cost of $774,630.17, and adds:

> If, after constructing a jetty of this kind, it is found that the bar has only moved farther out into the Gulf, which will probably be the case, it will then be necessary to prolong the jetty to the new position of the bar.
>
> The object of submitting this estimate is to show the cost of what is believed to be the best plan for improvement. The necessities of the case do not seem to call for such an expenditure.

From this time on nothing appears to have been done in regard to this harbor save the removal of a wreck in 1878, under an appropriation of $6,000 for the purpose.

The first appropriation for improvement proper at this point is by the terms of the act of Congress of June 14, 1880, $25,000.

In my annual report I say:

> In any plan suggested for the improvement of this harbor the sum available ($25,000) will not warrant actual commencement on the work. It is therefore recommended that the appropriation of $25,000 be held to await further action of Congress; and in the mean time measures may be taken in hand to project a defined plan for the expenditure of appropriations to follow hereafter.

From a study of Captain Adams's report and map of survey, 1871, and a Coast Survey chart of 1867, a tracing of an old map of the outlets of the Rio Grande River, and information derived from the examinations of Mr. S. W. Brooks, of Brownsville, during the past season, and a cursory examination by myself from the pilot-house of a steamer last spring, I am enabled to submit, with some confidence, a plan of operations that gives promise of improvement to a limited extent, probably sufficient to meet all requirements for many years to come.

I have laid down, on the accompanying tracing, lines marking approximately the position of two jetties or training walls, their object being to cut off the spread of water outside the gorge and concentrate whatever current there may be upon a limited extent of the bar, to thereby effect a deepening. No scouring effect is expected from the ordinary ebb and flood currents, as these are light, the mean rise and fall being but 0.7 foot.

It is believed, however, there are periodical storms that produce currents in the pass sufficient to make a deep channel across the bar, if properly controlled and directed. This control and direction I propose to give by the employment of training walls as shown on sketch.

Should, however, this expected scour not take place within a reasonable time after the completion of the walls, we may dredge a channel on the axis of the pass, and our walls will serve as a revetment to prevent the filling of the channel from the sides.

A very little deepening of the pass will answer all the requirements of commerce. The harbor room is very limited, only about 35 acres being inclosed by the 12-foot curve.

It is believed the bar is not composed entirely of sand, but is largely mixed with the sediment from the Rio Grande, which in times of freshets finds its way over shallows and flats lying between the river and Point Isabel, and debouches into the Gulf through Brazos Santiago Pass and Boca Chica, mingling its burden of clay with the sands of the Gulf shore. It may be advisable at some time in the future to shut off communication of the river with Brazos Santiago Pass by a dam running about east and west through Clark's Island to force the river overflows out by Boca Chica. There does not seem to be any immediate necessity for this.

I propose to build my walls of brush and concrete in the manner followed at other points on the Texas coast, and my estimate is based upon contract prices that obtain at Pass Cavallo Inlet to Matagorda Bay. I believe abundant brush can be procured in the vicinity of the work, while concrete must be manufactured on the spot for use as a substitute for stone.

SUMMARY OF ESTIMATES FOR THE IMPROVEMENT OF THE CHANNEL ACROSS THE BAR AT BRAZOS SANTIAGO, TEXAS.

South jetty (length 3,630 feet):		
26,339 cubic yards brush work, at $9.50		$250,220 50
14,330 cubic yards concrete work, at $7.50		107,475 00
		357,695 50
North jetty (length 2,940 feet):		
18,155 cubic yards brush work, at $9.50	$172,472 50	
9,372 cubic yards concrete work, at $7.50	70,290 00	
		242,762 50
Dredging channel 100 feet wide, 12 feet deep:		
32,871 cubic yards, at 50 cents		16,435 50
Total		616,893 50
Contingencies 20 per cent		123,378 70
Total cost		740,272 20

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Major of Engineers,
Bvt. Lieut. Col., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

PROJECT OF MAJOR S. M. MANSFIELD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 28, 1881.

GENERAL: In submitting my project herewith for the improvement of the harbor of Brazos Santiago, Tex., under the combined appropriations of—

1880	$25,000
1881	75,000
	100,000

I do so with some hesitancy, feeling sensible of the difficulties attending the inauguration of a work of this character in this locality, where the sea is generally rough, where materials for construction are not readily obtained, and where labor is difficult to manage.

On the 6th of January last I submitted to your office a report upon this contemplated improvement, with a plan and estimate. I have since given the subject a great deal of thought, and have instituted inquiries in every possible direction for information bearing upon the whole subject of the improvement, especially with reference to suitable materials for the work, and recently sent my assistant, Mr. Ripley, to make a reconnaissance in the neighborhood. His report is very full, and is submitted entire, as confirmatory of the views expressed in my letter of January 6.

Mr. Ripley makes a revised estimate of the cost of such a work, in which I concur, the estimate being about $5 per cubic yard for brush and stone in place, making for—

The south jetty	$190,901 75
The north jetty	129,203 75

It is difficult to estimate closely for a work of this character when so much depends upon the weather.

The cost of this kind of work at Galveston from January 1 to May 31, without considering the cost of plant, has been $2.90 per cubic yard. I think the above estimate of $5 the cubic yard will not be far from correct.

The first appropriation, of $25,000, was for improving the *bar;* the second appropriation, of $75,000, was for improving the *bar and harbor* of Brazos Santiago.

The construction of the dam in the lagoon seems to be an essential feature in the plan of improvement not so considered in my former report, both for increasing the depth of water on the bar and in the channel up to Point Isabel, and will render the improvement of the bar permanent; and at the same time it will increase the harbor capacity and afford a good channel up to Point Isabel. Its construction, however, should not be undertaken until funds sufficient for its completion are in hand, its cost being estimated at $327,979.

IN CONCLUSION.

I would build the south jetty first, then the dam in the lagoon, and finally north jetty.

The experience gained in this kind of work the past year at various points on this coast shows no difficulty of construction that cannot be readily overcome. At Galveston 8,000 feet of foundation mattresses, from 60 to 90 feet in width, have been laid, and at Aransas Pass over 2,000 feet, 56 feet in width, have been laid from the beach-line directly out into the Gulf, without loss of material and without any apparent settlement. The same thing can be done at Brazos Santiago; but delays and mishaps will be likely to attend the commencement of such a work there, and the cost at first will be greatly enhanced. If done by contract, these chances will have to be paid for, as no prudent contractor will fail to consider them in making his proposal.

I would recommend that the expenditure of the $100,000 in hand be made by commencing the work in accordance with the above views, and that the work be offered to contract in the usual manner.

Very respectfully, your obedient servant,

S. M. Mansfield,
Major of Engineers,
Bvt. Lieut. Col., U. S. A.

The Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
July 20, 1881.

Respectfully referred to the Board of Engineers for consideration and report of their views thereon.

The report of Colonel Mansfield of January 6, referred to, is herewith.

By command of Brigadier-General Wright.

JOHN G. PARKE,
Lieut. Colonel of Engineers,
Bvt. Maj. Gen., U. S. A.

[Second indorsement.]

OFFICE BOARD OF ENGINEERS,
New York, July 26, 1881.

Respectfully returned to the Chief of Engineers with report of this date.

Z. B. TOWER,
Colonel of Engrs. and Bvt. Maj. Gen.,
President of Board.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
August 19, 1881.

Respectfully submitted to the honorable the Secretary of War, with recommendation that the report of the Board be approved, and that this office be authorized to instruct Major Mansfield to proceed with the work in accordance therewith.

H. G. WRIGHT,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

Recommendation of the Chief of Engineers approved.

By order of the Secretary of War.

JOHN TWEEDALE,
Acting Chief Clerk.

WAR DEPARTMENT, *August* 23, 1881.

REPORT OF MR. H. C. RIPLEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 21, 1881.

COLONEL: In accordance with your instructions of the 20th ultimo, from which I make the following extracts:

"You will proceed by steamer to-morrow to Brazos Santiago and Brownsville, Tex., and make a reconnaissance of Brazos Santiago Pass from the bar in the Gulf to Point Isabel, in Laguna Madre, with a view to project a plan of improvement for navigation there under an appropriation of Congress of $100,000. You will examine the country thereabout and make all necessary inquiries about material applicable to our work, its cost and facility for handling. The labor question should also receive your attention.

"While at Brownsville you will please examine the work executed there last season for the protection of the river bank.

* * * * * * *

"Upon completion of this duty you will return to Galveston, Tex., and report"; I have the honor to make the following report:

As it was not possible for me to make any extended observations, I availed myself of every opportunity to obtain information from those most familiar with that section, and devoted my personal endeavors in a great measure to the verification of this information.

Capt. George Staples, of the Morgan steamer J. C. Harris, who has many years' acquaintance both with Brazos Santiago and the mouth of the Rio Grande, says that the littoral current is governed to a great extent by the direction of the wind. The southeast trades, which blow during the summer months, produce a northerly current along the shores of Brazos and Padre islands. The current has this direction about nine-tenths of the time. The northers of winter produce a current in the opposite direction. Captain Staples also says that the ebb and flood currents in the pass at times are very strong, making it necessary to let go two anchors to keep his ship from dragging. An observation for velocity of the flood current, taken May 29 by Lieutenant Sebree, of the Navy, in command of the United States Coast Survey steamer Gedney, gave a velocity of 3.8 miles per hour.

Captain Staples further says that clay bottom is found in 18 feet of water in the pass and in the Gulf anchorage just off the bar; but on the bar the bottom is all hard sand, which is easily shifted, as was shown by a recent occurrence. The pilot attempted to take the steamer (Harris) in on a falling tide. She was drawing 8 feet 2 inches, and struck the bar with but 7½ feet alongside. The tide continued to fall until there was but 6½ feet alongside, with a strong ebb current running. In this condition she was brought head on to the current by means of an anchor, and by working her engine ahead the sand washed away from her bottom and sides sufficiently to let her cross the bar, drawing 1 foot and 8 inches more water than was on the bar at the time.

Pilot Baker says that the deepest scour on the bar has never revealed anything but sand.

The pilots, as well as Captain Staples, say that a strong norther always improves the water on the bar by forcing the water rapidly out of the lagoon, and thus increasing the ebb current and consequent scour.

Northers, and especially northeasters, make it very rough on the bar. It is the opinion of Captain Staples that there is more rough weather at Brazos than at any other Gulf port.

From Mr. Deer, Captain Stone (employés of the Rio Grande Railroad Company), Pilots Baker and Hill, and other residents of Point Isabel, I learn that a strong norther raises the water in the lagoon at Point Isabel about 3 feet above ordinary tide, producing strong currents out of Brazos Pass down the lagoon towards Boca Chica, and out Boca Chica, often increasing the depth of water at the latter place from 1 or 2 feet to 12 feet. Mr. Gelston, of the firm of Woodhouse & Co., says that during the Mexican war large steamers with screw propellers crossed the bar without any delay; and Capt. Henry Miller, proprietor of Miller's Hotel, at Brownsville, who is a retired sea captain, says that in 1840 there was 18 feet of water on the Brazos Bar.

There are at present two channels across the bar of nearly equal depth. The direction of the main channel is nearly east, and has a depth of 7 feet at low-tide. The direction of the other is southeasterly, and has a somewhat less depth. This channel is a temporary one, and often becoming closed, a similar channel breaks through to the northeast, so that there are generally two channels in existence, the main one and one either north or south of it.

The material in the lagoon between Point Isabel and the pass is a mixture of sand and clay. The nearer the pass the greater is the proportion of sand. Further south towards Boca Chica the bottom is very soft mud. Dr. Wolf, the quarantine doctor at Brazos, says that Brazos Island, except a few feet of the surface (which is sand), is composed of stiff clay suitable for bricks. At Point Isabel there is a ridge lying northeast and southwest, about 30 feet high, upon which the light-house is situated, which is composed of clay. Where this ridge projects into the lagoon the earth stands nearly vertical.

Between Point Isabel and Brownsville numerous ridges are to be met, all having the same general appearance, indicating an ancient geological condition very different from the present.

The general impression prevails among persons acquainted with the harbor that it is being filled with sediment from the Rio Grande. To ascertain the grounds of this belief, and prove, if possible, the truth or falsity of it, I made a personal reconnaissance of the country from the river to the pass. At the time of this reconnaissance the river was at a stage about 3 feet above low-water, having fallen recently from a 10-foot rise to this stage. At a point about 12 miles by land from Brownsville there is a crevasse, known as Tuloso Bayou, 150 feet wide and 8 feet deep, with a velocity of current of 2 miles an hour (roughly measured). At low river the depth is 5 feet, and at high river 13 feet before the banks become submerged.

The accompanying tracing marked A is from a lithographic chart of a survey made in 1847, the original of which is in possession of Mr. S. W. Brooks, of Brownsville.

Since this survey the shallows extending from San Martin to Partrero Circado have been filled to a depth of several feet with sediment from this river. Bayou Tuloso runs in well-defined banks from the river to the Partrero Circado, the depth varying from 8 feet at the river to 2½ feet at the Partrero Circado at low-tide. From the latter place to Laguna Madre the bayou spreads out and becomes very shallow, having but 6 inches depth at low-tide, and has a deposit of 12 to 18 inches of very soft mud. The crevasse at San Martin has been many years closed. That at Tuloso broke through in 1870, and it is probable that the filling of the shallows has mostly been accomplished in the past eleven years. At high river the banks of the bayou are overflowed, and the principal deposit occurs near the river. At lower stages the sediment is carried farther down the bayou, and at low river it is poured directly into the lagoon. In this way the banks of the bayou are elevated and extended at every rise of the river. During high river the quantity of water finding its way from the river to the lagoon through this bayou and over the banks at other points further down is so great that the fresh water reaches and finds exit at Brazos Santiago.

There is also another way in which the river sediment may find a lodgment in the harbor, though probably to a very limited extent. The water from the river, after reaching the Gulf by its natural mouth, is often carried by the littoral current beyond Brazos Santiago. During flood-tide a portion of this water must enter the harbor and deposit its sediment here. On the 22d of May, the day of my arrival at Brazos, a streak of muddy water from the mouth of the river was distinctly traceable at the pass, and Lieutenant Sebree, of the United States Coast Survey steamer Gedney, has often noticed the same phenomenon.

A comparison of the Coast Survey chart of 1867 with the survey of 1871, by Lieutenant, now Capt. H. M. Adams, shows that the greatest depth in the pass has diminished from 40 feet in 1867 to 27½ in 1871, and the width between the 12-foot contours has diminished from 540 feet to 350 feet. At present Captain Staples says there is but 20 feet depth anywhere in the pass.

Another evidence of the harbor filling is shown in the formation of a middle ground between Point Isabel and Brazos, leaving a channel on either side of it. The depth of water in these channels is about the same as was to be found anywhere between Point Isabel and Brazos in 1867 (see tracing marked B), while on the middle ground and north and south of the channels there has been a shoaling.

CONCLUSIONS.

The conclusions which may be legitimately drawn from the information obtained are:

1st. A littoral current exists, the prevailing direction of which is north, but during northers its direction is south.

2d. The bar is composed of sand to a probable depth of 12 to 18 feet from the water-surface.

3d. There is undoubtedly sufficient current, if concentrated on the bar, to scour and maintain a depth of 12 feet or more.

4th. The mean rise and fall of the tide being but seven-tenths of a foot, the ordinary velocity of current in the pass must be very small compared with the velocity during northers; hence any plan of improvement to be effectual, to its fullest extent, should be so devised as to get the full benefit of the current caused by the northers.

5th. During northers a large percentage of the water of the lagoon is lost to Brazos by being driven by the pass and banked up in the lower end of the lagoon, filling the numerous shallows in that vicinity, and finally discharging through Boca Chica.

6th. The harbor is gradually, though surely, being filled by deposits from the river, and the rate of filling will be increased from year to year as the banks of Tuloso Bayou become raised above ordinary rises of the river, and so prevent the escape of the sediment which it carries until it reaches and is poured directly into the harbor. The harbor becoming filled, Brazos Santiago will be conjointly one of the mouths of the river and a pass from the lagoon to the Gulf, as Boca Chica now is, and will dwindle into insignificance, except at periods of storms or severe northers, when it is probable that a channel sufficient for the purposes of navigation may be maintained for a short time. It is evident, therefore, that any plan of improvement, to be permanent, must contemplate the complete exclusion of the river water from the harbor and pass.

7th. We have seen that the Rio Grande forms an important factor in devising a scheme of improvement for Brazos Santiago. Anything, therefore, relating to the physics of the river is pertinent to the subject.

The Rio Grande is eminently a sediment-bearing river. At all stages its waters are heavily charged with sediment. There is one peculiarity which is possessed by few, if by any, other rivers to the same degree, and that is the rapidity with which the suspended particles will subside when the water is brought to a perfect state of rest. Mr. Latimore, of Brownsville, who supplies the inhabitants with river water, says that he fills his tanks in the evening, and in the morning following it is perfectly clear and ready to draw off and deliver to his customers.

For many miles from its mouth the river flows through a valley of its own deposit. Through this valley it winds its way, making the average distance between two points by river about three times as great as by land. Like the Mississippi River, it has its shifting sand-bars and deep reaches, its caving banks and battures, its cut-offs and crescent lakes. At its mouth is found the inevitable bar, with an average depth upon its crest of about 4 feet.

Samples of sediment taken from the river bank at Brownsville and from Laguna Madre, about 1 mile south of Point Isabel, have a very similar appearance. Each sample is composed of a very fine calcareous sand, with a small amount of clay. That from the river bank has a pinkish tint and contains a larger proportion of clay than the other; that from the lagoon has a bluish-gray color, when dissolved in water and the water poured off so as to eliminate the clay; the residue from both looks exactly similar.

It is to be regretted that so little of the physical history of the river is known. It would be of interest in this connection to know why the river, being a sediment-bearing river, is not also a delta-forming river, if such be really the case. It seems probable that the river at one time debouched into Laguna Madre, and that in process of time it has extended its delta, cutting the lagoon in two and thus separating Laguna Madre of Texas from Laguna Madre of Mexico.

Supposing such to have been its history, will it continue its delta into the Gulf, or are its deposits swept away by the littoral currents of the Gulf? In the latter case the improvement at Brazos Santiago must be modified to meet the conditions.

PLAN OF IMPROVEMENT.

If the foregoing conclusions are even approximately correct, the general plan of improvement is quite obvious.

It should consist, in addition to the jetties already proposed, and which are shown on the tracing marked C, of a dam across the lagoon south of the harbor of sufficient height to prevent the escape of the water down the lagoon during the severest northers, and of sufficient compactness to arrest the sediment from the river and keep it from entering the harbor or pass.

A favorable location for this dam would be as shown on the accompanying tracing marked B.

This would give it a curved direction, which would facilitate the ingress and egress of the water to and from the lagoon, and also, by favoring the flow of the water in a single channel along the face of the dam, the tendency would be to extend the deep water of the pass toward Point Isabel, thus increasing the size of the harbor for deep-draught vessels and possibly avoid the necessity of lightering altogether. The curvature of this line is almost exactly the same as the course of the channel along the wharf front and to Fort Point, Galveston Harbor, where similar conditions maintain a deep and permanent channel. In the course of a few years the lagoon south of the dam will have become filled with deposits from the river, into which the dam will be incorporated, making it secure against all future cyclones.

AVAILABLE MATERIAL.

Nothing in the line of lumber or piling can be obtained in this vicinity. Lumber brought from Louisiana and Florida is retailed in Brownsville at $40 per thousand feet B. M. Freight from Brazos to Brownsville is very expensive, and it is quite probable that lumber in quantities can be delivered at Brazos for $30.

Brush suitable for fascines is not abundant. The great mass of the brush, which grows almost everywhere in the valley, is mesquite and ebony, and both are thorny. But in the vicinity of Tuloso Bayou, on the river, there is willow in sufficient quantities perhaps for the entire work. In case there be not sufficient at this point, at Col. J. G. Tucker's ranch at Santa Maria (90 miles by river above Brownsville) there are about 300 acres of good thornless brush. It is principally hackberry, but there is considerable willow and some ash and elm. It is probable, however, with further search, that plenty of good willow brush can be found along the river within a few miles of Tuloso.

Cane is to be found in limited quantities at different points along the river, and I am assured by Mr. Field, chief engineer of Brownsville (once connected with the Rio Grande Railroad), that cane is to be found in unlimited quantities only a few miles above Santa Maria on the river.

It is believed, therefore, with a suitable plant for transporting brush from the river through Tuloso Bayou, that it can be delivered at Brazos at a very reasonable price

Stone it will be difficult and costly to obtain. As far as I could learn, the only stone at all suitable for ballast is to be found near Rio Grande City, about 300 miles by river from Brownsville. This is a fine calcareous sandstone, with a specific gravity of 2.3, and weighs 143 pounds per cubic foot. It can be delivered at Point Isabel for $7.50 per ton. There is a similar stone found near Penitos, about 200 miles from Brownsville, but it is too friable to be of any value as ballast. I obtained a sample of stone from up Laguna Madre, which might possibly be obtained, but if this sample be a fair specimen it is unsuitable for the work. There is one other source from which stone may be obtained in the future, and that is from the Matamoras-Monterey Railroad, which is now being extended towards the latter place, having been purchased recently by Palmer and Sullivan. Its present length is about 7 miles.

No gravel or shell with which to make concrete can be obtained short of 200 miles up the river from Brownsville. Good bricks, however, can be made very cheaply. They can be had in Brownsville in any quantity for $4 per thousand. If the clay at Point Isabel be found suitable for the purpose, they can be made there at about the same price.

Fuel is very cheap. Good mesquite wood can be had in Brownsville for $3 per cord, and it will cost but little more at Point Isabel. There is this certainty, however, that bricks can be furnished, delivered by rail from Brownsville at Point Isabel, for $7 per thousand, equal to $4 per ton.

If properly burnt and of suitable dimensions, this will furnish an economical material for ballast, nearly if not quite as good as any stone that can be obtained.

LABOR.

Unskilled Mexican labor is very abundant and cheap; but white, and especially white skilled labor, is costly. Common Mexican labor in Brownsville is worth 50 cents per day without board, and picked labor 75 cents. At Brazos it will cost a little more, probably 75 cents and board, or about $1 per day.

CONSTRUCTION.

I would therefore respectfully recommend that for the bulk of both the jetties and the dam, brush, made into mattresses, and bricks of special form (to be determined by experiment), be used. The dam should have a base of 30 feet and a top width of 15 feet, and a height sufficient to come to the water-surface at ordinary high-water. Above this it should have a superstructure consisting of a single row of piles 4 feet from centers, closely planted on one side to a height of 3 feet, with 3-inch plank.

Such a structure will be permanent as regards the brush-work and ballast, and the superstructure being out of water, except during northers and extraordinary tides, if kept coal-tarred, will last a great many years and can be renewed when necessary at a small cost. Less costly methods of construction might be adopted, but they all lack the element of permanence which this possesses, and are not enough cheaper to make their construction and renewal economical.

PLANT.

To conduct the work economically, quite an extensive plant will be required. For the transportation of brush down Tuloso Bayou it will be necessary to have three light-draught flat-boats and one light-draught steam-barge, with sufficient power to stem a 3-mile current in a narrow bayou with a flat in tow. For the construction of the jetties there will be needed two good barges for carrying ballast and sinking mattresses, and one light-draught tow-boat for towing barges and mattresses to the side of the jetties. There will also be needed one steam pile-driver and a cheap wharf and ways for landing brush and making mattresses upon.

ORDER OF PROSECUTION.

The order of prosecuting the work should be, first, the construction of the south jetty; second, the construction of the dam; and, third, the construction of the north jetty.

The south jetty will intercept the drift material brought from the south by the littoral current, causing a building out of the shore-line on the south side, and prevent, until this reaches the end of the jetty, any deposition on the bar from this direction. During northers it will confine the water to a single channel across the bar, answering, together with the wind and littoral current from the north, every purpose of two jetties.

The dam will greatly increase the discharge during northers, and if built first would have the effect of pushing the bar farther out, and hence increase the cost of the jetties.

The construction of the north jetty will complete the improvement and will insure a permanently good channel during all seasons and stages of tide.

The construction of the dam should not be commenced until there are funds sufficient to complete it, for its partial completion can be of but little benefit, and leaving it so any length of time might very materially increase its final cost.

ESTIMATES.

Detailed estimates of the cost of constructing two jetties across the bar as proposed by you have been made. The jetties to be made of brush mattresses, similar to those used in the improvement of Aransas Pass and Galveston Harbor, ballasted with bricks. Also detailed estimates have been made of the cost of constructing a dam from Point Isabel to Brazos Island, on the line proposed, after three methods. These estimates will be found at the close of this report.

The summary is as follows:

South jetty	$190,901 75
North jetty	129,203 75
Dam	327,979 00
Plant	30,000 00
Total	678,084 50

COMMERCIAL STATISTICS.

Col. J. S. Haynes, collector of the port of Brownsville, has kindly furnished the commercial statistics of the port. From his letter, herewith accompanying, it will be seen that the commerce of Brazos Santiago is of no insignificant importance.

RIVER BANK PROTECTION.

I made an examination of the work for the protection of the river bank at Brownsville and found that it had been entirely effectual except at one place. For a distance of about 100 feet, extending downstream from the prolongation of the east face of the administration building, there has been a settlement of several feet. This settlement was evidently the result of a substratum having been dissolved away, but how this could have been accomplished with the whole bank protected down to the very bottom of the river, no satisfactory explanation can be given. Colonel Otis, the commandant of the post, has repaired this portion by covering it with loose brush held with chains attached to "dead men" back in the bank, and ballasted with iron rubbish from the wreck Rio Bravo. It is also partially covered with earth. Aside from this the bank is in good condition. It is overgrown with grass, and the willows planted in rows 7 feet apart are most of them growing nicely.

In closing, I desire to express my indebtedness to those citizens of Brownsville and Point Isabel whom I had the pleasure of meeting for courtesies extended and information freely given. But especially am I indebted to the officers of the Rio Grande Railroad Company and Morgan Line, and to Mr. S. W. Brooks, of Brownsville, and Col. J. G. Tucker, of Santa Maria.

Very respectfully, your obedient servant,

H. C. Ripley,
Assistant Engineer.

Bvt. Lieut. Col. S. M. Mansfield,
Major of Engineers, U. S. A.

ESTIMATED COST OF TWO JETTIES AT BRAZOS SANTIAGO, TEX.

South jetty (length 3,630 feet):

26,339 cubic yards brush work, at $2.50	$65,847 50
18,000 tons of brick, at $4.50	81,000 00
	146,847 50
Contingencies, 30 per cent	44,054 25
Total	190,901 75

North jetty (length 2,940 feet):	
18,155 cubic yards brush work, at $2.50	$45,387 50
12,000 tons of brick, at $4.50	54,000 00
	99,387 50
Contingencies, 30 per cent	29,816 25
Total	129,203 75
For both jetties	320,105 50

ESTIMATED COST OF DAM FROM POINT ISABEL TO BRAZOS SANTIAGO.

(To be built of brush mattresses ballasted with brick and with a superstructure of piles and plank—length, 14,000 feet.)

44,000 cubic yards brush work, at $2.50	$110,000 00
30,140 tons of bricks, at $4.50	135,630 00
280,000 feet, B. M., pine, 8 by 8 inches by 15 feet, at 30 cents	8,400 00
126,000 feet, B. M., pine, 3 by 12 inches, at 30 cents	3,780 00
34,095 pounds screw-bolts, ⅞ by 12 inches, at 10 cents	3,410 00
1,260 pounds washers, at 6 cents	76 00
Labor:	
Driving 3,500 piles, at $2	7,000 00
Bolting in place 126,000 feet plank, at 2 cents	2,520 00
Coal-tarring (labor and material)	2,500 00
	273,316 00
Contingencies, 20 per cent	54,663 00
Total	327,979 00

ESTIMATED COST OF DAM FROM POINT ISABEL TO BRAZOS SANTIAGO.

(To consist of a row of close piling, supported by a second row at intervals of 5 feet—length, 14,000 feet.)

16,800 piles, 12 by 12 inches by 20 feet, at $7.20	$120,960 00
112,000 feet, B. M., pine, 6 by 8 inches, at 30 cents	3,360 00
52,370 pounds screw-bolts (1 by 28 inches), at 10 cents	5,237 00
800 pounds washers, at 6 cents	48 00
Labor:	
Driving 16,800 piles, at $2	33,600 00
Halving 5,600 piles, at 12½ cents	700 00
Bolting 112,000 feet waling, at 2 cents	2,240 00
Creosoting 4,144,000 feet, B. M., at 2½ cents	103,600 00
	269,745 00
Contingencies, 20 per cent	53,949 00
Total	323,694 00

ESTIMATED COST OF DAM FROM POINT ISABEL TO BRAZOS SANTIAGO.

(Constructed of two rows of piles 8 feet apart (piles in rows 5 feet from centers), tied together and space filled with brush facines ballasted with bricks—length 14,000 feet.)

5,600 piles, 10 by 10 inches by 20 feet, at $5	$28,000 00
59,733 feet, B. M., cross-ties, 4 by 8 inches by 8 feet, at $30	1,792 00
84,000 feet, B. M., waling, 3 by 12 inches	2,520 00
32,870 pounds screw-bolts, ¾ by 14¼ inches, at 10 cents	3,287 00
27,690 pounds screw-bolts, ¾ by 15¼ inches, at 10 cents	2,769 00
2,800 washers, at 6 cents	168 00
7,000 cords brush facines, at $5	35,000 00
11,000 tons of brick in place, at $4.50	49,500 00

Labor:	
Driving 5,600 piles, at $2	11,200 00
Bolting 143,733 feet lumber, at 2 cents	2,875 00
Creosoting 1,077,000 feet, B. M., at 2½ cents	26,925 00
	164,036 00
Contingencies, 20 per cent	32,807 00
Total	196,843 00

ESTIMATED COST OF PLANT.

One tow-boat	$12,000 00
Two barges	5,000 00
One steam-barge	5,000 00
Three flat-boats	3,000 00
One steam pile-driver	3,000 00
Wharf and ways	2,000 00
Total	30,000 00

COMMERCIAL STATISTICS.

CUSTOM HOUSE, BROWNSVILLE, TEX,
Collector's Office, June 14, 1881.

SIR: In reply to your letter of June 8, 1881, requesting to be furnished with commercial statistics of this port for the past year, and for five years, in order to show the importance of Brazos Santiago as a port, I have the honor to inform you that for the past year, commencing July 1, 1880, the imports of the district amount to $2,347,778, exports, $2,503,852, aggregating $4,851,630; and for the past five years averaging $4,000,000 to $5,000,000 in value per annum.

The above statistics are derived from the records of this office, which do not embrace domestic cargo arriving in vessels of the United States in coasting trade, which amount would augment the given commerce of the port to $8,000,000 or more per annum, very nearly all passing through the port of Brazos Santiago.

Very respectfully,

J. L. HAYNES,
Collector.

H. C. RIPLEY, Esq.,
Assistant Engineer.

REPORT OF THE BOARD OF ENGINEERS.

OFFICE OF BOARD OF ENGINEERS FOR FORTIFICATIONS
AND FOR RIVER AND HARBOR IMPROVEMENTS, &c.,
New York, July 25, 1881.

GENERAL: The Board of Engineers having considered the project of Major Mansfield, Corps of Engineers, for improving the harbor of Brazos Santiago, referred to it for report by your indorsement of the 20th instant, has the honor to submit the following report thereon.

The bar at the mouth of the Rio Grande has a depth of only 4 feet, making it necessary to shift all Gulf freight bound to or from Brownsville and points above. The harbor of Brazos Santiago, situated 10 miles from the mouth of the river is used for this purpose. It affords a small but secure anchorage of about 35 acres, inclosed by the 12-foot curve and having a maximum depth of 27 feet.

Like all Gulf harbors the entrance is obstructed by a shifting sandbar, which here has a natural depth of about 7 feet. Overflow water from the river, charged with sedimentary matter, escapes at high stages over the left bank and is slowly filling up the lagoons leading to the harbor of Brazos Santiago, and perhaps injuring the harbor itself. The project under consideration is for increasing the depth over the bar and for improving the harbor, for which two appropriations aggregating $100,000 are available.

No expenditures of this nature have heretofore been made at this harbor, but the bar has been repeatedly examined with a view to devising plans for obtaining entrance for a larger class of vessels. This was done by Captain McClellan in 1853, by Lieut. H. M. Adams in 1871, and very recently by Major Mansfield, now in charge of the work. These engineers all agree that nothing can be accomplished by dredging or scraping the bar. Jetties or training walls are accordingly projected.

The bar projects from the land on the sides of the pass in the usual curved form seaward. It is fully exposed to the action of storms, and is reported to consist of a hard sand formation easily acted upon by water in motion, but no borings are mentioned.

The Laguna Madre affords an immense interior reservoir area for maintaining a flow through the pass, but as the average tidal oscillation is restricted to about 7 inches, dependence can only be had upon wind-currents to keep the channel open. Northers act very powerfully at times. Sweeping down the Laguna Madre, they raise the level of the surface at Point Isabel 3 feet above ordinary tides, producing a strong current through the pass. A velocity of 3.8 miles per hour was measured there in last May.

The prevailing winds blow from the southward during about nine months of the year, and from the northward for the remaining three, and they are said to cause a littoral current dependent upon their direction, duration, and force. Unless such currents suffice to remove the material to be pushed from the bar by the action of the proposed jetties, it will be necessary to extend them continually. Only vague information has been collected on this point.

At the narrowest point of the pass, between Brazos and Padre islands, the width is about 1,100 feet, and the mid-channel depth over 20 feet. Major Mansfield proposes to extend two parallel jetties constructed of brush mattresses, in the manner now in use on the Texas coast, and loaded with brick made on the spot, entirely across the bar to the 12-foot curve. The width between these jetties is to be about the same as the narrowest part of the pass. The south jetty is to be 3,630 feet long and the north jetty 2,940 feet. Their direction is in the prolongation of the pass. The estimated cost of the former is about $190,000, and of the latter $130,000.

Major Mansfield also projects a dam extending from Brazos Island to Point Isabel, designed to increase the depth of water on the bar and in the channel to Point Isabel, by preventing the flow towards Boca Chica. Its cost is estimated at about $328,000.

The Board approves this system for improving the harbor of Brazos Santiago so far as to recommend that the funds available be applied to constructing the south jetty as projected by Major Mansfield. Its tendency will be—

1. To partially restrict the spreading of the waters at the mouth of the pass, and thus to cause increased excavating action at the bar, especially during the prevalence of the northerly winds, which are most effective. The water escaping from the pass will then be confined and aided by the presence of any southern littoral current, also due to this wind.

2. During southerly winds this jetty for a time will preserve the chan-

nel thus formed from being again closed by sand rolling northward along the shore of Brazos Island.

The information collected during the construction of this jetty and the effects produced by it will render it possible to decide with greater certainty than at present how far it will be necessary to extend the north jetty and whether a somewhat shorter one may not suffice.

The question of an interior dam can well be left until after the completion of the jetties, and the Board therefore refrains from expressing any opinion thereon.

Respectfully submitted.

Z. B. TOWER,
Colonel of Engineers and Bvt. Maj. Gen.
JOHN NEWTON,
Colonel of Engineers and Bvt. Maj. Gen.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

O 9.

PROTECTION OF RIVER BANK AT FORT BROWN, TEXAS.

First appropriation (1876)	$10,000
Second (1879)	7,000
Total	17,000

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1882.

Since the close of operations at this point in the fiscal year 1880–'81, nothing whatever has been done by the Engineer Department by way of actual work in protecting the bank of the river.

The following correspondence explains the reason for not recommending any further expenditure of public money in efforts to protect the government reservation by arresting the progress of encroachment of the river upon the bank.

Money statement.

July 1, 1881, amount available	$230 04
July 1, 1882, amount available	230 04
Amount appropriated by act passed August 2, 1882	1,000 00
Amount available for fiscal year ending June 30, 1883	1,230 04

LETTER OF COL. C. H. SMITH, NINETEENTH INFANTRY.

HEADQUARTERS, FORT BROWN, TEXAS,
January 9, 1882.

SIR: I respectfully report that the river is cutting its bank opposite the lower end of the lagoon. Only 30 feet of ground intervenes between the river and the lagoon. The swamp extends some distance above and below the threatened point, and the place cannot be approached by a team.

There is danger of the river cutting through and draining the water out of the lagoon. I see no way of arresting it with the present resources of the post; do not see how I can even attempt it. I am very anxious to have the matter examined and reported upon by an inspector from department headquarters, and request that the inspector promised early in January to examine the matter of removing the work-shops may come as soon as possible, and that he be instructed to examine the matter of the river bank.

Very respectfully, your obedient servant,

C. H. SMITH,
Colonel, Nineteenth Infantry, Commanding Post.

Official:

THOMAS M. VINCENT,
Assistant Adjutant-General, Department of Texas.

HEADQUARTERS DEPARTMENT OF TEXAS,
San Antonio, January 16, 1882.

Respectfully forwarded to the adjutant-general Military Division of the Missouri, with request that an officer of the Engineers be sent to examine and report as to the threatened cut.

Lieutenant-Colonel Gregory, A. D. C., has had to do with the protection of the bank under consideration, and therefore can fully advise the Lieutenant-General.

Prompt action should be had, as the post commander has exhausted the resources of the post in attempting to stop the inroad.

C. C. AUGUR,
Brigadier-General, Commanding.

[First indorsement.]

HEADQUARTERS MILITARY DIVISION MISSOURI,
Chicago, January 21, 1882.

Respectfully forwarded to the Adjutant-General of the Army, for the Secretary of War, in connection with a conversation which the Lieutenant-General had with him on the subject.

In absence and by order of the Lieutenant-General commanding.

R. WILLIAMS,
Assistant Adjutant-General.

[Second indorsement.]

HEADQUARTERS OF THE ARMY,
Washington, January 24, 1882.

Respectfully submitted to the Secretary of War.

I understood Colonel Otis, Twentieth Infantry, recently transferred to Fort Leavenworth from Fort Brown, to say that the Rio Grande River was rapidly cutting away the banks, endangering the site of Fort Brown.

This may be the reason why the owners of the ground are so anxious to sell to the United States.

W. T. SHERMAN, *General.*

[Third indorsement.]

Respectfully referred to the Chief of Engineers for report.

By order of the Secretary of War.

H. T. CROSBY, *Chief Clerk.*

WAR DEPARTMENT, *January* 28, 1882.

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS, UNITED STATES ARMY,
February 1, 1882.

Respectfully referred to Maj. S. M. Mansfield, Corps of Engineers, for early report. To be returned.

By command of Brigadier-General Wright.

JOHN G. PARKE,
Lieutenant-Colonel of Engineers,
Bvt. Maj. Gen., U. S. A.

[Fifth indorsement.]

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., March 4, 1882.

Respectfully returned, and attention invited to letter from the Secretary of War in relation to an appropriation for the protection of the river banks of the Rio Grande upon the site of Fort Brown, Texas. (Executive document No. 153, Forty-third Congress, first session, House of Representatives.) See report of Lieut. (now Capt.) H. M. Adams, May 28, 1873, published therewith, for difficulties of protecting the site and value of buildings endangered. Recommends river be allowed to take its own course, because—

1st. Protection of banks would require more than value of buildings endangered would warrant.

2d. Land does not belong to United States.

3d. Buildings becoming endangered could be taken down or moved back from time to time, as necessity requires.

Quartermaster-General, twelfth indorsement, June 23, 1873, concurs in above opinion.

Amount expended by Engineer Department $17,000, in addition to work by Quartermaster's Department and the post garrison, all of which is practically gone, as well as some private work in front of the city of Brownsville.

I do not think it in the power of any one to say how much money and time must be expended to protect the river banks at this point.

The engineer who should undertake work should have control of both banks of the river. I believe the river will now cut through into the lagoon in spite of anything we can do, and I concur with Captain Adams and General Meigs in the opinion that it is not expedient to attempt to control the Rio Grande at this point by artificial constructions, and that it is better to move from time to time such of the buildings as may be in actual danger.

S. M. MANSFIELD,
Major of Engineers,
Brevet Lieutenant-Colonel, U. S. A.

LETTER FROM THE ADJUTANT-GENERAL TO THE LIEUTENANT-GENERAL.

HEADQUARTERS OF THE ARMY,
ADJUTANT-GENERAL'S OFFICE,
Washington, March 17, 1882.

SIR: Referring to your indorsement of January 21, 1882, from your headquarters, upon copy of communication from the commanding officer, Fort Brown, Texas, who reports that the Rio Grande is cutting its bank opposite the lower end of the lagoon, which is in danger of being drained by the river, and requests that an officer of Engineers be sent to report on the matter, in which request the department commander concurs, I have the honor to inclose herewith copy of a report by Maj. S. M. Mansfield, Corps of Engineers, Galveston, Tex., to whom the paper was referred, and by direction of the General of the Army to inform you that the opinion of Major Mansfield therein expressed, "that it is not expedient to attempt to control the Rio Grande at this point by artificial construction, and that it is better to move from time to time such of the buildings as may be in actual danger," is concurred in by the Secretary of War.

I am, sir, very respectfully, your obedient servant,

R. C. DRUM,
Adjutant-General.

Lieut. Gen. P. H. SHERIDAN,
Commanding Military Division of Missouri.

O 10.

SURVEY OF MATAGORDA BAY AT THE MOUTH OF SAINT MARY'S BAYOU, NEAR THE TOWN OF MATAGORDA, TEXAS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., November 25, 1881.

GENERAL: I have the honor to transmit herewith a chart of Matagorda Bay at the mouth of Saint Mary's Bayou, near the town of Matagorda, Tex., together with the report of Assistant Engineer John M. Picton of his survey made under my direction in accordance with the act of Congress approved March 3, 1881.

MATAGORDA BAY.

At present there is a channel of 2 feet depth across the bar at mean low-tide, but during the extreme low-water of winter, caused by northers, the bar itself is visible above the water surface.

Dredging would seem to be the best means of deepening the channel across the bar; being stiff mud, would probably remain open some time without revetment. Mr. Picton makes an estimate of $10,000 for dredging a channel 3 feet deep, 100 feet wide at bottom, and slope one on two.

Commercial statistics are wanting; but from statements supplied by some of the leading merchants it is learned that a business of about $175,000 is transacted in general merchandise; 474 bales of cotton, 50 sacks of wool 9,000 hides were the principal exports during 1880.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Major of Engineers,
Brevet Lieut. Col., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. JOHN M. PICTON, ASSISTANT ENGINEER.

GALVESTON, TEX., *September* 17, 1881.

COLONEL: I have the honor to submit the following report of the "survey of Matagorda Bay at the mouth of Saint Mary's Bayou, near the town of Matagorda, Tex."

* * * * * *

The survey was made during a low stage of the Colorado River, and is as complete as the time would allow. Its purpose was to ascertain the depth of water across the bar and the best means of improvement.

* * * * * * *

A record of the tide was kept during the time of survey, and readings taken every hour during daylight. The bayou being so far from the tidal entrance of Matagorda Bay (40 miles), very little of the Gulf tide reaches it; consequently the daily range is very small and caused principally by wind. The series of observations for tide were not extended enough to accurately establish the plane of mean low-tide, only two minimums being observed. A reading of 3 feet on the gauge was assumed as the plane of reference. The highest tide observed was seven-tenths of a foot above, and the lowest tide two-tenths of a foot below this plane.

About 4 miles below the mouth of Saint Mary's Bayou, a reef, principally of oyster shells, and with three small channels through it, extends entirely across the bay, and greatly obstructs the admission of the flood-tide into the upper bay. The most northerly of the three channels crossing it is known as "Dog Island Channel," and was opened by citizens of Matagorda County, and has a least depth at ordinary tide of 3 feet. The most southerly of these channels crosses the reef near Matagorda peninsula, where it is much narrower and composed of sand. Any improvement contemplating a greater depth than 3 feet across the bar at the mouth of Saint Mary's Bayou would be useless until the depth across the reef was correspondingly increased. Of the three channels, the one near Matagorda peninsula is most susceptible of improvement, the reef being of sand at this point, and the distance to deep water on either side not very great.

Saint Mary's Bayou empties into Matagorda Bay, at the town of Matagorda, and inside of the bar has a depth of more than 16 feet. The left bank is several feet high with an abrupt slope toward the bayou at Matagorda street, but is low and flat above and below, where it is generally overflowed during high river. The right bank, except directly opposite Matagorda street, is low and marshy, and is covered with tall reeds which grow some distance into the bayou and bay, but opposite that street there is a high ridge which runs parallel to the shore, is partly cultivated, and has some timber upon it. Several years ago the sediment from the east branch of the Colorado River was swept to the northeastward and deposited in front of the bayou, which succeeded in almost closing the entrance; but recently the river broke into the bayou through a small canal, so that now the bayou is virtually one of its mouths. Since the crevasse was formed uniting the river and bayou there has been an increased depth of water across the bar, due to the current during freshets. At present there is a channel of 2 feet depth across the bar at mean low-tide, but during the extreme low-water of winter, caused by northers, the bar itself is visible above the water surface.

Matagorda is a town of 500 inhabitants, is situated on the left bank of Saint Mary's Bayou at its mouth, and is the county seat of Matagorda County. According to the statements of its citizens it was once a thriving town, with a depth of channel across the bar of 3½ or 4 feet, but during the gradual shoaling of the entrance of the bayou has dwindled into insignificance.

The soil of Matagorda County is black and red loam, and is very fertile. It is principally a cotton-growing and cattle-raising county, and produced last year 12,000 bales of cotton, which, on account of the shoal water on the bar, was carried by rail to market.

The banks of the Colorado River are covered with brush, principally willow, hackberry, and elm, and gravel, shell, and sand are to be found in large quantities in the vicinity of its mouth. There is no stone to be found for some distance up the river.

PROPOSED IMPROVEMENT.

Improvement by means of jetties would have to depend for its success upon ebb-tide currents strong enough to produce the required scour, but the bayou does not form a reservoir sufficient for the reception of any considerable amount of flood-water, and hence cannot give any great velocity of ebb-current. Any strong currents would be due to freshets, which are unreliable, and occur only during a portion of the year. In view of these facts, dredging would seem to be the best means of deepening the channel across the bar. The material of the bar being stiff mud would probably remain open some time without revetment.

The estimate for dredging a channel 3 feet in depth, 100 feet wide at bottom, and slope 1 on 2, is as follows:

30,700 cubic yards, at 25 cents	$7,675
Cost of transporting dredge	1,000
	8,675
Add about 15 per cent. contingencies, &c	1,325
Total cost	10,000

The actual amount of dredging for a 3-foot channel is 8,985 cubic yards, but on account of the shoalness of the water it will be necessary to excavate a much larger amount to allow a dredge to pass through the cut. The estimate is made for a channel of 3 feet depth, as that is the greatest depth that can be carried across the reef.

* * * * * * * *

Very respectfully, your obedient servant,

JOHN M. PICTON,
United States Assistant Engineer.

Bvt. Lt. Col. S. M. MANSFIELD,
Major of Engineers, U. S. A.

APPENDIX P.

PRESERVATION OF THE PORTS OF MEMPHIS, VICKSBURG, AND NATCHEZ; IMPROVEMENT OF THE MOUTH OF RED RIVER; OF THE RAFT IN UPPER RED RIVER, LOUISIANA AND ARKANSAS; OF CERTAIN RIVERS IN MISSISSIPPI AND TENNESSEE; WATER-GAUGES ON THE MISSISSIPPI AND ITS PRINCIPAL TRIBUTARIES.

REPORT OF MAJOR W. H. H. BENYAURD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Mississippi River and Harbor at Memphis, Tenn.
2. Mississippi River and Harbor at Vicksburg, Miss.
3. Mississippi River at Natchez and Vidalia, Miss.
4. Mouth of Red River, Louisiana.
5. Removing raft in Red River and closing Tone's Bayou.
6. Removing obstructions from Red River, Louisiana.
7. Upper Red River, Arkansas, from Fulton to the head of the raft.
8. Yazoo River, Mississippi.
9. Big Sunflower River, Mississippi.
10. Tallahatchee River, Mississippi.
11. Coldwater River, Mississippi.
12. Tchula Lake, Mississippi.
13. Yallabusha River, Mississippi.
14. Big Hatchie River, Tennessee.
15. Ouachita River, Arkansas and Louisiana.
16. Bayou Bartholomew, Louisiana and Arkansas.
17. Tensas River, Louisiana.
18. Bayou Bœuf, Louisiana.
19. Cypress Bayou, Texas and Louisiana.
20. Water-gauges on the Mississippi River and its principal tributaries.

EXAMINATIONS AND SURVEYS.

21. Bear Creek, running into Yazoo River.
22. Big Black River, Mississippi.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., July 27, 1882.

GENERAL: I have the honor to transmit herewith annual reports upon the works of river and harbor improvement under my charge for the fiscal year ending June 30, 1882.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

P 1.

IMPROVEMENT OF THE MISSISSIPPI RIVER AND HARBOR AT MEMPHIS, TENNESSEE.

Early in August, when a favorable stage of water was reached, an examination was made of the entire front for the purpose of ascertaining the condition of the work already accomplished. It was found that some additional caving had taken place in that portion of the front above the new elevator embraced within the limits of the coal landings. The caving was evidently due or hastened by the action of the cove people cutting into the banks for the purpose of making roads to their flats. As this caving to some extent endangered the adjoining portions of the revetment, work was commenced at once upon the necessary repairs.

During the season, sixteen mattresses were constructed and placed in position, covering an area of 10,000 square yards. In addition, 1,460 square yards of upper bank was revetted, making a total bank covering of 11,460 square yards. As the changes taking place in the bend above Hopefield will in time affect the direction of the current in front of the city, a report was forwarded to the department in connection with a petition from the city authorities, chamber of commerce, and cotton exchange, outlining additional work.

This new project and estimate was submitted to the department on March 6, 1882.

As the work will hereafter be under the supervision of the Mississippi River Commission, in accordance with the river and harbor act of August 2, 1882, it is presumed an allotment for further work will be made from the appropriation for the improvement of the Mississippi River.

For the details of the operations during the past season I refer to the report of Mr. H. B. Herr, assistant engineer, herewith.

The first estimate for this work was $170,000, of which there has been appropriated $113,000.

The second estimate, submitted last March, was $204,211.

The former appropriations are as follows:

By act approved June 18, 1878	$46,000 00
By act approved March 3, 1879	37,000 00
By act approved June 14, 1880	15,000 00
By act approved March 3, 1881	15,000 00

The above work was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A., on June 30, 1882.

Money statement.

July 1, 1881, amount available	$16,090 54
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	15,370 40
July 1, 1882, amount available	720 14

COMMERCIAL STATISTICS.

Amount of cotton received from September 1, 1881, to June 30, 1882:

	Bales.
By rail	203,237
By steamboat	93,862
By wagons, &c	37,887
Total received	334,986

Amount of cotton shipped from September 1, 1881, to June 30, 1882:

	Bales.
By rail	231,291
By steamboat	102,013
Total shipped	333,304

Number of landings made by steamboats annually, 3,600.

The collections at custom-house in Memphis, Tenn., during the year ending June 30, 1882, are as follows:

Duties on imports	$7,110 43
Hospital dues (marine)	2,236 12
Steamboat inspection	2,069 95
Licenses to masters, engineers, pilots, &c	2,300 50
Total	13,717 00

REPORT OF MR. H. B. HERR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., January 25, 1882.

MAJOR: I have the honor to present the following report of operations pertaining to the improvement of the Mississippi River and Memphis Harbor at Memphis, Tenn., during the working season of 1881.

In accordance with your verbal instructions I relieved Mr. Joseph Burney, assistant engineer, of the supervision of this work on July 8, 1881. At this time the boats and pile-driver were undergoing the necessary repairs preparatory to the resumption of work as soon as the stage of water would permit.

From the results of an examination of the bank and revetment on the city front, made during low-water in December, 1880, by Mr. Burney (see his report on page 1,383 of Chief of Engineers' Report for 1881), only some slight repairs of the mattress revetment were anticipated, and the project for the season's operations included, in addition to this repairing, a continuance of the open-dike work inaugurated during the previous season above the mouth of Wolf River. The high stage of water at the time I took charge being favorable for driving piles on the slope above low-water, it was commenced at once and prosecuted vigorously, with the object and in the manner described following:

OPEN-DIKE WORK.

The results obtained by the mere beginning in 1880 of the system of floating dikes proposed for the maintenance of the rapidly caving bank from Tennessee Chute to mouth of Wolf River, indicate its efficiency in producing a deposit along the base of a caving bank, thereby arresting its further destruction. The floating screens or timber frames anchored below low-water had retained their floating power, but those anchored on the slope above low-water were found to have become partially imbedded in a deposit of sand when the water had receded below them, so that on a second rise of the river they did not respond, but remained on the bottom, having no effect in arresting velocity of the current during any subsequent high-water. In consequence the current is at liberty to pass down along the bank with its full force, and unless the same substantial connection of the second dike with the bank is secured as in the first dike erosion must take place there. The same is true of all the remaining dikes of the system. Now, if that portion of the first or upper dike extending from low-water to top of bank can be made permanent, a checking of the current will be secured from the outer end of the dike to the bank crest, and the bank, from first to second dike, be relieved from the otherwise strong current. This would probably dispense with the necessity for continuing any of the other dikes up the slope above low-water. To consummate this object the following plan was adopted:

CONSTRUCTION.

Commencing near the top of the bank and about 50 feet above the first line of floating dikes, two parallel lines of piling, 8 feet apart were driven. The distance between piles in each line was also 8 feet, and each in the upper line had a corresponding one opposite in the lower line. They varied in length from 20 to 60 feet in going from the top of bank down the slope to line of low-water. A slight inclination downstream was given to the direction of this line of work to give some facility for the escape of drift. The piles were sawed off at 8 feet below high-water mark to allow drift to pass over during highest stages of river. Without this precaution the pressure against the work would be so great that it could scarcely withstand it; and no harm could result to the bank from the surface current. When this double line of piles had been completed to about low-water line, further operations were suspended, and the entire working force applied to repairing the revetment on city front. In this work 52 piles were driven.

It was the intention to have extended the piling to some distance below low-water line, to give ample protection to the shore end of floating dike; this part to have a more decided turn downstream, and tops to be sawed off 15 feet below high-water. The two lines of piles were to be firmly braced together, and each pile in the lower line to be additionally braced by a shore heeled into a heavy, short, ground post driven at a proper distance below. On the upper side of lower line of piles wale pieces, 4 by 6 inches and 1 foot apart, were to be spiked horizontally. The waling to extend from the bottom to top of piling. This arrangement would, to a certain extent, divide the pressure to be sustained between the two lines of piles, as the upper one would receive the main bulk and pressure of drift.

MATTRESS REVETMENT.

Early in August, the water having declined to about 8 feet on the gauge, a favorable opportunity was offered for ascertaining the condition of the bank and revetment along the city front. A careful examination showed some additional caving of bank and damage to the revetment to have occurred during the recent high-water, and consequently more repairs were necessary than had been anticipated. Upon consultation with you it was decided to suspend work above mouth of Wolf River at once, and if possible complete the repairs of mattress revetment along the front.

The principal caving was in the stretch from foot of Market street to foot of Poplar street, where a width of 50 feet had caved or sloughed off at several points since the revetment was completed in 1880, though the width was, as a rule, much less. Messrs. Brown & Jones's Coal Landing, also the site of Bryan & Co.'s Coal Landing (abandoned some months since), are included in this distance, and have probably been active, if not principal, agents in hastening the dissolution of the bank throughout this stretch. The mattresses in the revetment being found substantially where they were placed, except that they have sunk vertically downward, indicates that the initial point of the caving is not at a great depth, as was the case before the revetment was laid, but along the bank edge of the mattress work, and progressive downward under the revetment, as well as shoreward and into the bank. Many coal flats moored over the bank edge of the revetment during higher stages of water may have induced a cutting beneath them, and possibly the cartways leading from floating flats to top of bank, being carved out of the steep slope, may have had a pernicious effect also.

Another agency in the rapid destruction of the bank is the storm water from the streets of the city. Instead of being led down to the river in water-tight conduits discharging on top of the revetment, it is permitted to find its way from the end of street gutters down the slope over and through the bank to the river below; keeping the bank material in an almost constantly saturated condition, and to some extent facilitating its dissolution when acted upon by the river water.

Since the continued destruction of the bank, after the revetment was laid, has its origin above the upper or bank edge of the revetment, in order to render the protection entirely effective, it should be continued up the slope to near high-water, the bank being properly graded to receive the upper portion. With the small amount of funds available this could not be entered upon, without neglecting the repairs requiring immediate attention.

CONSTRUCTION.

The mattress ways previously used were repaired and utilized for this season's work. In accordance with your suggestion, instead of using poles and pins for mattress frame, wire was used, and the following method in framing and construction was adopted: No. 10 annealed wire was stretched across the ways from end to end, at intervals of 6 feet; the ends of each run of wire, after taking a turn around a binding-pole, being fastened temporarily to a stout stake. Another set of wires was stretched across these, also at intervals of 6 feet, the ends secured after passing around a binding-pole, in same manner as first set. At each intersection both wires were caught in the bight of a short tie-wire (No. 12 annealed), both parts of which, after being properly twisted to hold bottom wires firmly, were led up along a stake driven at the intersection and temporarily fastened at the top of stake. These stakes projecting about 2 feet above the ways served the purpose of preventing the longitudinal wires and willow brush from sliding down on the sloping ways, as well as temporarily holding the tie-wires. On this bottom frame willow brush was laid in four alternating courses with a total thickness of 18 inches. The top frame wires were then stretched over this to correspond with those below, their ends being firmly fastened to a line of poles extending along the entire edge of the mattress. These top binding-poles had previously been substantially and tightly wired to those below, the two sets forming a firm and enduring selvage around the mattress, giving a stanch bearing for the frame wires and obviating any raveling or ragging of the edges. When all ends of frame wires had been properly fastened, the tie wires, before described, were released from their temporary holding-stakes and made fast to the upper frame at each intersection of top wires. A man at each of the two parts of tie-wire, using heavy pliers, would tie top and bottom frame so closely and firmly that no other appliance was necessary for compressing the brush before tying.' A compressing-jack, made for the purpose, was used in tying top and bottom poles together.

Dimensions of mattresses were 125 by 50 feet 18 inches, except the last three, which, on account of submergence of lower side of ways, were only 38 feet wide.

The substitution of wire for poles and pins has proved highly satisfactory, both as to cost of material and efficiency. The wired mattress is more pliable, accommodating itself readily to any irregularities of river bottom, is stronger, and of course more durable.

LAUNCHING.

After withdrawing the temporary stakes driven at each intersection of frame wires, all temporary holding-wires were cut except those on the upper edge of mattress, and the usual check and anchor lines attached. Then the upper holding-wires were cut simultaneously, when the mattress would move gently downward off the ways, usually without any other force than its own weight.

PLACING MATTRESSES IN POSITION.

In this operation the method was substantially the same as that followed during the previous season, except as to quality of ballast and the manner of using it. Screened gravel, ranging in size from about one-quarter inch to two inches in diameter, obtained from gravel bars in the near vicinity, was used instead of stone, and with quite satisfactory results. The cost per cubic yard delivered on our flats, by contract, was $1.50, whereas stone had been delivered heretofore at $2.45 per cubic yard, or at a cost of about $40 more per mattress for stone than for gravel.

In sinking our first mattresses in a moderate depth of water, and on a gently sloping bottom, the gravel was simply thrown on in a loose condition, and worked admirably; but in deeper water (40 to 60 feet), where a stronger current produced great whorls and boils, this did not suffice. The vibratory motion induced in the mattress, under these circumstances, while the ballast was being placed preparatory to a final submergence and more especially while the mattress was moving down to the bottom, a large portion of the smaller gravel sifted through the brush-work. This loss of ballast was particularly noticeable in the behavior of a mattress sunk in a depth, at outer end, of 50 feet of water. Almost immediately after reaching the bottom (determined by sounding-lead) the outer end rose to the surface, and but little gravel was found remaining on it. To obviate this the gravel was placed in sacks containing about 130 pounds each; these were wired to the mattress, one at each intersection of the top wires, and as many more at different places as were necessary to ballast sufficiently and uniformly before submergence commenced. The remaining ballast requisite to sink and hold the mattress snugly to the bottom was simply thrown on after being sacked. Although the results obtained in this way were excellent, particularly as to the preliminary loading, I would prefer stone for the final sinking and ballasting. In deep water and a strong current the sacks were carried so far down stream in their transit from surface to bottom that it was difficult to know where they should strike the surface that they would reach a particular final position on the mattress below. It is true a similar difficulty is presented in the use of stone, but to a less degree.

Contrary to any precedent during the past ten years, the low-water season ended early in October instead of in December, as had usually been the case. In consequence this working season has been unexpectedly short, and an increased cost attended the later work done, on account of increased difficulty in securing willow brush, and a partial submergence of the mattress-ways during the higher stage of water. But for this unforeseen early rise of the river probably the entire repairs of the revetment below low-water would have been completed, whereas about one-fourth remained unfinished when the rising water enforced a suspension of work. During this short season, with a small force of laborers and much sickness during the hot summer days, sixteen mattresses were constructed and placed in position, covering a total area of 10,000 square yards.

When mattress construction was no longer possible, a barge-load of willow brush remained on hand. With this a portion of the upper bank was revetted by laying the brush in three alternating courses, with a total thickness of 18 inches, the whole held down by wires attached to stakes 4 by 6 inches, driven into the graded slope before the brush was laid. After fastening wires to the stakes they were driven still deeper, until the wires were stretched taut over the brush. A good ballast of stone was then placed on top. In this manner 1,460 square yards were covered, making a total of 11,460 square yards of revetment laid during the season.

On suspension of operations the boats, with all property pertaining to the improvement, were laid up at Fort Pickering in charge of proper watchmen.

SUMMARY OF MATERIAL USED.

Number of piles driven:		
Open-dike work	52	
In revetment	36	
		88
Cords of—		
Willow brush		1,546
Cottonwood poles		10
Pounds wire		2,430
Cubic yards—		
Gravel		570
Stone		187
Number of bags for gravel (second-hand oil-cake)		1,750

Respectfully, your obedient servant,

H. B. Herr,
Assistant Engineer.

Maj. W. H. H. Benyaurd,
United States Engineer Corps.

P 2.

IMPROVEMENT OF THE MISSISSIPPI RIVER AND HARBOR AT VICKSBURG.

It was first contemplated this past season to commence the dredging of the inner harbor as originally recommended by the Board of Engineers. It was thought advisable, however, to continue the revetment of the Delta Point for the purpose of rendering that bank thoroughly secure, as a protection to the inner-harbor work. It was necessary to repair the plant, which was done, and in addition a new set of ways for constructing a continuous mattress was built, and a steam-pump was purchased to be used in bank-grading. These preliminary preparations occupied the time up to November 21, at which date the mattress work was commenced. This continued with some auxiliary dike work until January 10, when high-water put a stop to further operations for the season.

Seven hundred and fifty feet of mattress was constructed and sunk for the protection of the bank. It may be necessary to continue this work down to the extreme point of the bar, unless the change now taking place in the direction of the current above King's Point should render that portion of the bank perfectly safe from caving.

During the coming season it is proposed with the balance of the appropriation left over to continue said work if necessary, and with the new appropriation it is proposed to commence the work of dredging out the basin and channel of the inner harbor, as recommended by the Board of Engineers. The work will be done by contract.

The former appropriations are as follows:

By act approved June 18, 1878	$84,000
By act approved March 3, 1879	50,000
By act approved June 14, 1880	20,000
By act approved March 3, 1881	75,000

For details I respectfully refer to the report of Mr. T. G. Dabney, assistant engineer, herewith.

On the 30th of June I transferred the above work to Capt. A. M. Miller, Corps of Engineers, U. S. A.

Money statement.

July 1, 1881, amount available	$74,646 95
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	46,952 34
July 1, 1882, amount available	27,694 61

COMMERCIAL STATISTICS.

The total amount of cotton shipped from the port of Vicksburg from September 1, 1881, to June 9, 1882, 140,052 bales. Of this amount 50,240 bales were handled by the compress alone. In addition to this there were shipped from Delta in the same period 29,691 bales, which were brought in by rail, besides local shipments amounting to 1,560 bales, and 85,000 sacks of cotton-seed.

The estimated value of the commerce of Vicksburg, outside of the cotton receipts, is between $7,000,000 and $8,000,000.

REPORT OF MR. T. G. DABNEY, ASSISTANT ENGINEER.

VICKSBURG, MISS., *March* 1, 1882.

MAJOR: In tendering my resignation of the position I have heretofore occupied in your service, I respectfully submit the following report of operations on the work under my charge during the working season just passed.

It was expected that the work of revetting the upper bank of the Delta peninsula with mattresses, down to its extremity, would be completed this season, and that the appropriation already made would be sufficient for that purpose.

These conclusions were both based upon the assumption that the whole of the low-water season would be utilized in progressing with the work, and that there would be no diversion of any considerable portion of the fund from the direct purpose of making and sinking mattresses. It was found, however, that much preparatory work was necessary in renewing plant, &c., and the appropriation was made available at so late a period that the preparations began at the time when the work proper should have been under full headway, and, owing to extraordinary causes of delay and difficulties, the entire low-water season was consumed in preparatory work, so that the first mattress was not sunk until November 21, when the river had attained the height of 28 feet on the gauge, and was rising so rapidly that it speedily reached a stage at which the work could not be prosecuted with economy or certain efficiency.

Under these circumstances no effort would have been made to continue the revetment this season, but for the absolute necessity of protecting, if possible, the lower end of the old work, which was threatened with destruction by the coming flood-water. With this view the work was pushed under adverse conditions until January 10, when the river had gotten too high to proceed further with the mattress-work. A permeable floating wooden dike was afterward sunk on the revetment, just above the lower extremity, with a view to breaking up a troublesome eddy which had formed there, and was attacking the work.

The necessity for restricting expenditures as far as practicable to the direct work in hand has made it expedient to pursue a make-shift policy in purchasing barges and other plant. In order to make the partial appropriations for each season go as far as possible, such plant as would require the least present outlay was used, chiefly with a view to its lasting through that particular season. This is of course, ultimately, anything but economy, and, in consequence of this policy, it was found at the beginning of the present season that the whole of the plant on hand was in a deplorably bad condition, scarcely a barge, in fact, fit for further service. The floating "ways" for mattress construction, which had been made in the latter end of the year 1878, with foundation consisting of the bottoms of two old coal boats, were dropping to pieces, and totally unfit for use. A new set of "ways" was made at a cost of $3,714.80. Two sinking flats were constructed to replace two that were past service. These consisted of coal-boat bottoms, 175 feet long and 25 feet wide, with supplemental "gunnels," 5 by 16 inches, placed on the old "gunnels." The cost of these, including purchase of coal boats, was about $400 each, notwithstanding that a good deal of old iron was used in their construction. Three other boats were purchased at a cost, respectively, of $200, $225, and $500, each of which required further outlay for calking, modifying, and repairing. Another barge, 16 feet wide and 98 feet long, was purchased for $150, and used for a "pump-boat," to be further described. Lines, tackle, and other plant had to be replaced at considerable cost.

Another element of cost not foreseen is the grading and revetment of the bank above low-water line, as experience and subsequent observation have demonstrated the necessity of protecting this portion of the bank as well as that part below low-water line.

About 3,300 feet linear extent of bank should be treated in this way, requiring the removal of about 45,000 cubic yards of earth to reduce the bank to a slope of one to one, which is deemed essential. This grading, at 15 cents per cubic yard, would cost $6,750, if done with ordinary appliances, with, however, considerable practical difficulty in disposing of the earth removed, as it would pile up just below the water-line and necessitate the previous revetting of the lower slope.

In order to facilitate and cheapen this part of the work, it was determined to wash the bank to the proper slope by a jet of water delivered by a powerful pump, which, besides saving in cost, would dissolve and more readily dispose of the material washed down.

To this end a "pump-boat" was fitted up, furnished with a large fire-pump, a "Dayton cam pump" being selected. This pump has a steam cylinder 16¼ by 18 inches, and water-plunger 9 inches diameter, with two 4-inch discharge pipes. It is provided with a boiler 42 inches diameter and 20 feet long, with two 14-inch flues. This machinery was fitted up on a barge 16 feet wide, 98 feet long, and 3½ feet deep, which was decked and housed over with roof and sides. The total cost of boat, machinery, and all necessary fixtures, fitting up, &c., was $3,679.

A "Worthington compound duplex pump" was preferred, but it was found impossible to get an order for one filled in any definite time.

It is estimated that the work of washing down the bank will cost 2 cents per cubic yard, based upon similar work performed in the Missouri River by Maj. Charles R. Suter, United States Engineer, or say $1,000 for the whole work, which would make the cost $4,679 against $6,750 by hand.

The "pump-boat" was not in readiness for work until the river became too high to use it to any purpose, but some experimental work was done with satisfactory results, suggesting, however, some necessary modifications in the nozzles used and in the steam-generating arrangements, which have since been made, and it is now ready for service.

It was intended to make the experiment of completing the lower slope revetment with a continuous willow mat 1 foot thick and 155 feet wide, and with this object the new "ways" were constructed with a shear or rake on the shore end, in order to carry the edge of mat far enough above water line to make secure connection with upper bank revetment. The season was so far advanced, however, before active work could be begun, the river rising rapidly and much drift-wood running, that it was deemed too hazardous to make such experiment, and operations were confined to making and sinking detached mattresses and a floating dike. The construction of these mattreses was modified to the method intended for the continuous mat, that is, the frames of poles at bottom and top were entirely discarded, these being found by experience to be an element of great weakness, from the necessity of boring 1-inch holes through the poles for the reception of hickory pins. It had before been found necessary to supplement the poles and pins largely with wire, and even then without very satisfactory results. The present method of construction is very satisfactory, giving a strong, compact, and flexible mattress. Longitudinal poles are first laid on the "ways," transverse to the "runs," about 8 feet apart. These are simply to facilitate launching, which it was found impossible to do without them. Upon these poles is laid a wire netting of same dimensions as the mattress. The netting is composed of No. 8 wire, in meshes 2 feet square. The willows are then placed on in three layers to the thickness of 1 foot, the middle one being transverse to the upper and lower. The willows are then sewed to the wire frames with No. 12 wire, the seams being longitudinal with the mattress and 4 feet apart. To facilitate this operation there is a floor on the "ways," 4 feet below the top of "runs," to enable men to go under the mattress. Each seam is carried on by two men, one above and the other below. The man above carries an iron needle of five-eighth inch iron, 3 feet long, with an open slot or eye near the point, and the other end turned over so as to form a handle. The lower man carries the coil of wire. The upper man thrusts his needle through the willows at intervals of 2 feet. The man underneath places the bight of the wire in the eye and the needle is drawn up, carrying the bight of the wire through to the top. A wooden toggle 3 feet long is passed under the bight of the wire, which is secured to it by two fence staples driven into the toggle. A single wire is carried along each seam on top of the willows, and a turn taken with it around the bight of the lower wire under each toggle. This makes the whole structure strong and secure.

The wire netting is made with rapidity and facility upon a skeleton drum 12 feet in circumference, which extends the whole length of the "ways," on a projecting platform, on a level with the floor along the upper side. It was designed for making continuous netting for the continuous mat. It is intended to cover the upper slope, when properly graded, with a revetment of willows, disposed with a view to their taking root and growing, this material being otherwise so perishable as to last but a short time.

It was determined to make the experiment of sinking permeable floating dikes, to test the utility of their application under the conditions which obtain here. With this view a number of structures were made of 3 by 4 feet cypress lumber, wood being used for the advantage of its buoyancy, in panels 20 by 40 feet. These panels were joined together in varying numbers, according to the depth of water where they were intended to be sunk, so as to form sections of dike 40 feet wide, and extending from the river bottom well above low-water level. In the lower panels the lumber was disposed horizontally, with 6-inch spaces, and bolted to vertical pieces 5 feet apart, with three-eighth inch bolts. In the upper panel the lumber was arranged vertically, with 3-inch spaces similarly bolted to transverse pieces, the lumber so disposed that the smaller dimension, 3 inches, is presented to the current. The panels were joined together by shackles and links of three-fourth inch iron, there being 9 such fastenings to each joint. The bottom panels were so shaped as to conform to the slope of the river bottom where they were intended to be placed. Above the lower edge of the bottom panel was framed a box, rigidly attached, and extending the entire length of the lower edge of panel. The box was, in section, 4 feet wide at the top, 3 feet at the bottom, and 4 feet deep, and was intended to hold ballast for sinking the dike. This form of box was afterwards discarded, and instead was substituted a detached box, in section, 4 feet at the bottom, 2 feet at the top, and 4 feet deep, interior measurement. The box is 40 feet long and divided into 4 compartments of 10 feet each, constructed of 3 by 4 lumber secured by bolts, and attached to the lower edge of the bottom panel by shackles and links, forming a joint which allows freedom of motion to the dike. It is thought it will act as a modified "Chinese anchor," the ends of the timbers being allowed to project so as to catch in the bottom of the river.

As it was necessary to revet the bottom before sinking the dike, the latter was deferred until the mattress-work was suspended, at which time the river was very high, with strong current, and much drift-wood running, which was very unpropitious for the dike experiment. After some disastrous efforts, owing to the defective form of the anchor boxes first used, a dike was placed in position just above the lower extremity of the revetment, extending 200 feet out from the bank. The buoyancy afforded by the lumber used in the construction of the dike was assisted by attaching empty oil casks to the upper edge, 8 or 9 casks to each section of 40 feet. Two panels of the outer section of this dike came up several days after it was sunk, and it was found that the timbers to which the connecting shackles were bolted had given way, notwithstanding that the end of the timber enforced by the shackle had a bolt through it transverse to the shackle bolt.

It is very desirable that the dike experiment be repeated under more favorable circumstances. There are now on hand enough panels already constructed to form another dike 300 feet long.

There were made and sunk 16 willow mattresses, each 50 by 150 feet and 1 foot thick. These were composed exclusively of willows and wire, in the mattress proper, with cribs of poles for holding ballast wired to the upper surface, and the poles used underneath to facilitate launching the mattresses from the ways. Of these mattresses twelve were sunk on the lower slope, that is, below low-water line, and the remaining four were sunk when the water was at a high stage, parallel to the bank, crossing the shore ends of the others, and covering the upper bank nearly to the top. In this way 600 feet linear extent of bank was covered, leaving about 1,800 feet linear extent of lower slope to be revetted, and about 3,300 feet of upper bank to be graded and revetted.

The method intended for the treatment of the upper bank is, first, to grade it to a slope of one to one from about low-water line to upper surface. Then, at intervals of 6 feet, to bury poles 6 inches in diameter 3 feet deep from top to bottom of slope, at right angles to water's edge; these poles to carry straps of No. 8 wire at intervals of 6 feet, reaching well above ground; the willows to be placed on the surface in bundles 8 inches thick, in one layer, with butts towards the water, upon which are to be laid poles, at intervals of 6 feet, transverse to direction of willows, and strapped to buried poles by the wire straps; the butts of the willows to be well covered with earth, by which means it is thought they will take root and grow. For the lower slope it is designed to sink continuous mats of willows 1 foot thick, constructed as the above described mattresses, to be 155 feet wide, and in length of, say, 1,000 feet, or such other lengths as may be found to be most practicable in application; the shore edge of this mat to be securely attached to the upper bank revetment. It is estimated that this work will cost $44,000.

Description of "ways" for the construction of continuous mat: These are composed of, first, two barges, each 20 by 150 feet and 3 feet deep. The "gunnels" are of cypress, the bottom ones 8 inches thick and the top ones 6 inches. The bottoms of barges are of long-leaf, yellow-heart pine, 2½ inches thick. The barges have a "rake" at one end, with a view to crowding the "ways" close inshore, for the construction in site of continuous willow matting.

The two barges were placed parallel to each other, 9 feet apart, and rigidly connected together by a beam, 8 by 18 inches and 30 feet long, bolted across each end. The space between the barges is spanned at intervals of 5½ feet by 4 by 6 sills, which support the posts on which the "runs" rest. There are also horizontal diagonal braces between the barges, to give longitudinal stiffness. The "runs" are transverse to the length of the barges, and are 5 feet 6 inches between centers. They are 4 by 6 cypress, beveled on the upper edge, with 1¼-inch strap-iron screwed on. They are supported by 4 by 6 posts, 6¼ feet apart, which rest on 4 by 6 sills across the bottoms of the barges.

The top of "runs" on the higher side of ways is 13 feet 3 inches above bottom of barges, and they have a slope of 5 feet 9 inches vertical, in a horizontal distance of 37 feet, at which point there is an angle in the slope, which descends 5 feet 8 inches in a horizontal distance of 19¼ feet, the "runs" extending to surface of water 8 feet outside of the outer barge. The lower ends of "runs" rest upon a guard sill, 4 by 10, to which they are bolted, the guard sill being parallel to side of barge. A floor is placed 4 feet below top of "runs" and parallel thereto, to enable men to work underneath the mat. It also serves to brace the uprights which support the "runs." A platform, 8 feet wide, projects from the upper side of the ways on a level with the upper edge of floor, and extends the whole length of the ways. Along this platform is a "drum" for the making of wire netting. It consists of a skeleton wooden frame with a central shaft of 6 by 6 feet timber. Around this frame are fitted wrought-iron bands, 1½ inches wide and one-fourth inch thick, with a circumference of 12 feet. These are disposed in pairs, the bands in each pair being 6 inches apart, and the pairs being 2 feet between centers. Around the whole circumference of the bands are nibs of round iron, one-half inch diameter, projecting 1½ inches from the bands and riveted on the under side.

The nibs are disposed in pairs, with a clear space of 1 inch between nibs and 12 inches between centers of pairs. In making netting with meshes 1 by 2 feet, all of the pairs of nibs are used. When the meshes are 2 by 2 feet only the alternate pairs are used. The bands are adjusted so as to bring the nibs opposite to each other on their respective bands, and make continuous lines along the whole length of drum. In making the netting the wire is carried along the drum between the nibs so as to create a lap, a double wire between the bands composing each pair, when it is twisted together by inserting a steel pin between the strands.

The idea of this "drum" was obtained from Mr. L. E. Cooley, assistant engineer, by whom I believe it was first devised.

Very respectfully,

T. G. Dabney,
Assistant Engineer.

Maj. W. H. H. Benyaurd,
Corps of Engineers, U. S. A.

P 3.

IMPROVEMENT OF THE MISSISSIPPI RIVER AT NATCHEZ AND VIDALIA.

In July, 1881, I made an examination of the river about Natchez, with a view of presenting a project for carrying on the work during that season.

It was found that the river had cut through into Lake Concordia at one point, and that it was therefore unnecessary, at least for the present, to continue the work in Marengo Bend. The nature of the bed of the lake was such as to preclude the idea that the river could, in a short time, cut its way entirely into the lake, and make the latter the main channel.

In Giles Bend it was found that the extensive caving noticed the season before still continued, with a probability that the river would, in the course of a few years, cut through the neck of land from Giles Bend to Cowper Bend, and destroy the approaches to Natchez and Vidalia. It was, therefore, determined to commence the season's work upon the revetment and protection of the caving banks in Giles Bend.

The appropriation was not sufficiently large to admit of an extensive application of mattress revetment for the entire length of the bend, and therefore instructions were issued to the assistant to use, in connection therewith, a combination of open dike-work such as we had experimented with at Memphis the season before.

About 4,500 linear feet of bank was protected by this latter work. The reports from the locality indicate that the caving has been stopped along the entire front covered. The high stage of water prevailing throughout the entire season has, however, prevented us from determining fully the true value of the work, and to what extent it has been successful in preventing the rapid caving of banks in water of so great a depth.

For the full details of the operations and the application of wooden screens and the work of bank protection, reference is made to the report of Mr. Joseph Burney, assistant engineer, herewith.

As the Mississippi River Commission will hereafter have supervision of the work, in accordance with the provisions of the recent river and harbor act, it is presumed that an allotment for the coming season's work will be made from the appropriation for the improvement of the Mississippi River, and therefore no estimate is presented.

The former appropriations are as follows:

By act approved January 14, 1880	$40,000 00
By act approved March 3, 1881	50,000 00
The amount expended up to the close of the fiscal year ending June 30, 1881, was	40,147 22
The amount expended during the fiscal year ending June 30, 1882, was	41,600 74

On the 30th of June this work was transferred to Capt. A. M. Miller, Corps of Engineers.

Money statement.

July 1, 1881, amount available	$49,852 78
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	41,600 74
July 1, 1882, amount available	8,252 04

COMMERCIAL STATISTICS.

Natchez contains about 9,000 inhabitants and receives and ships about 40,000 bales of cotton per year. Sales of merchandise, $1,900,000. Number of landings made by steamboats at wharf, 1,300.

Vidalia, La., immediately opposite Natchez, contains about 650 inhabitants and ships about 8,000 bales of cotton annually. The port of entry is New Orleans.

REPORT OF MR. JOSEPH BURNEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., May 18, 1882.

MAJOR: I have the honor to submit report of operations for the protection of the harbors of Natchez, Miss., and Vidalia, La., during the year ending June 30, 1882.

In July, 1881, I received your instructions to relieve Mr. T. G. Dabney, assistant engineer, who was at that time in local charge of the work.

July 13, 1881, I met yourself and Mr. Dabney at Natchez, the tug I. B. O'Brien was engaged, and an examination of the harbor and the bends above was made.

The harbor was found to be in excellent condition, free from caving banks, with a slight exception below Vidalia on the Louisiana shore, and to be one of the best and safest between Saint Louis and New Orleans.

Leaving Natchez and proceeding up the river, great changes were found to be taking place from the constant caving of the bank above Palo Alto Point, about 3 miles from Natchez, on the Louisiana shore.

Immediately behind the bank lies Lake Concordia, and there is every reason to believe that the river will break through into the lake, the latter thereby becoming the main river; but from examinations made by the late Mr. Melvin, assistant engineer, no danger to the harbor will occur from this, and the caving will stop, as the bed and banks of the lake are composed of stiff blue clay.

From Palo Alto Point to Bullet's Bayou, a distance of 6 miles, rapid caving is going on to within a short distance of the bayou. In 1880 and 1881 a number of willow mattresses were sunk under your direction near the bayou, which have stopped the caving at that point.

From above Bullet's Bayou a large sand-bar extends from the Louisiana shore 3,100 feet into the river, and throws the main channel on the Mississippi shore (making a very sharp bend in the river, and forming a long neck of land immediately above Natchez), which threatens to cut across the point, as it has done at Vicksburg, and destroy the harbors of Natchez and Vidalia.

The distance around the bend is about 8 miles, and across the point 1 mile, which is rapidly decreasing by the caving of the bank on the upper side. At present this point is covered by a heavy growth of timber, vines, and underbrush, which affords great protection to the banks; but the timber is being rapidly cleared away and the land prepared for cultivation.

During the present high-water the water was over 5 feet deep on this point, and if the timber and brush had not broken the force of the current, it must have scoured out a deep channel. At "Devil's Elbow Cut-off," about 25 miles above Memphis, the river broke through in one night, a distance nearly equal to that across the point at Natchez, the land in that locality having been cleared and put under cultivation; also at "Vicksburg Cut-off" the land had been cleared across the point. Captain Ernst, in his report on the improvement of the Mississippi River (see Report of Chief of Engineers for 1880, vol. 2, page 1359), testifies to the great protection afforded by the timber on the banks of the river, illustrating the subject with several plates. In my examinations of the river I can support his opinion where he states: "An examination of the shore line shows that in every case where cleared fields along a caving bank are interrupted by a patch of woods the latter project into the river. It is easy to believe that the binding quality of the roots and the protection formed by the fallen trees at the foot of the bank should have this effect."

I believe that if the timber and underbrush on this point at Natchez be cut off, any work which the government may undertake to prevent the river breaking through will be useless. It is true the work may prevent it for a time, but, in order to finally succeed, the timber on the point should be protected.

As the greatest danger to the Natchez Harbor was from the river breaking across this point, you directed that work should be commenced on this bend. The original design was to protect the entire bend with mattresses, at an estimated cost of $284,400; but, as the amount of money available was entirely insufficient for this kind of protection, the design was changed to a combination of mattress-work and floating-screen protection, and I received from you the following instructions:

To protect the bank by mattress-work and floating screens. To commence the work slightly above the caving bank and continue it down to a little above the extreme point of the sand-bar. The distance between these two points was found to be 3,800 feet. The bank to be protected by five lines of works, as follows:

On each line, the upper bank to be cut to a suitable slope for mattress-work; then from the top of the bank to the bed of the river to be protected with one continuous line of mattress-work, 55 feet wide and 2.5 feet thick. Upon this foundation screens to be placed at a slight angle downstream, running from low-water on bank, 400 feet into main channel of river. From low-water mark to upper bank, screens of shorter lengths to be constructed. An estimate was made of the cost and it was considered the work could be done for $35,000.

I immediately commenced active operations in August, 1881. The tug Clarence, of Memphis, was chartered and arrived at the works August 12.

In addition to the tug I had the following floating plant; floating mattress-ways, recently used at Vicksburg; one flat-boat, decked over, 175 by 25 feet, having two small derricks used in sinking screens; one quarter-boat for workmen, capable of accommodating one hundred men.

We purchased one coal shell-boat for $80. The boat was 175 by 25 feet. We cut it in two, making two flat boats out of it—one boat being 100 by 25 feet, the other 75 by 25 feet. These boats were used for carrying stone, poles, and willow brush. This comprised all our floating plant and was found amply sufficient for the execution of the work.

I then staked out the location for each of the five lines, and found they averaged about 880 feet apart. The banks were graded down and one mattress, 130 by 55 by 2.5 feet, sunk a short distance from shore in front of each line. A smaller mattress was then constructed, 60 by 55 by 2.5 feet, and sunk, one end close to the bank and the other end overlaping the first mattress from 10 to 15 feet. Then the shore-work was securely fastened to mattress No. 2, and carried up to the top of the bank, thus forming one continuous line as instructed. The whole of the mattress-work was given a heavy ballasting of stone, and the shore-work above water entirely covered with earth to keep it from drying out. (For detailed description of mattresses and method of sinking, see report on Memphis Harbor, Chief of Engineers' Report for 1878–'79.)

Screens.—Considerable study has been given to the subject of floating screens as a means of protection for the banks of the Mississippi River by yourself and assistants. In 18[illegible]8 and 1879 I received your instructions to use screens for the protection of Memphis Harbor, the location being above Wolf River and a short distance below Old Hen Island, but the yellow fever prevented me from carrying out your instructions. At that time you had under consideration what is known as "Scott's wrack heap-dike protection," but after careful consideration this was rejected on account of its impracticability.

In the first place, this project requires large trees to be obtained, having on all their upper branches. It is only with great difficulty and expense these can be got into the river; then the butt is sunk to the bed of the river, leaving the top floating near the surface to collect drift material brought down by the current. This would force the current down on the unprotected bed, and prove a positive injury instead of protection. This plan might be useful in shallow streams where small trees might be used, covering and protecting the bed, and the drift building upon it would form nearly a solid jetty. But in the Lower Mississippi in deep water I believe this plan would prove a complete failure. In 1881 experiments with screens were made at Memphis Harbor. The location chosen was on a sand-bar on which the current had commenced to cut. Immediately below the bar the current struck the bank, and it was caving fast. We first secured the foundation for our screens as directed by you to be done at Natchez.

We then constructed a variety of screens, built of cottonwood or willow poles, interlaced with willow brush; others, with cane. These stopped nearly the whole of the water. Towards the water edge we placed poles close together, but giving more water space than the willow and cane screens. Out in a stage of 20 feet of water we sunk a screen, 60 by 30 feet, made of sawn lumber. Cross-pieces, 6 by 4 inches, were placed 10 feet apart. Across those pieces scantlings, 3 by 4 inches, were placed, leaving a 3-inch water opening between. Above the screens and mattress-work we drove piles to keep off the drift-wood. Near the shore we placed one row, further off we placed two rows, and in the water at a low stage three rows. The piles were all strongly braced and bolted together.

After accomplishing this work was suspended. The river rose, bringing down a quantity of heavy drift, which lodged against the piles and was backed up for over 500 feet and in places 8 feet deep. A strong current ran under the drift, and but for the mattress-work would have rapidly cut out the sand-bar. The drift would have made a good breakwater could it have been retained, but the pressure became so great against the piling it broke away, and the drift floated over the screens without doing any damage. The screens broke the current above and below them, and drew the water from the bank. At the outer end of screens a very swift current was running. At the next low-water an examination was made, and the result was satisfactory. It was found the close screens had collected a quantity of sediment, but the deposit was immediately upon the screens. The screens with wider openings had not collected so much sediment upon them, but the deposit was over a wider area above and below. In places the fill was over 10 feet.

As the sawn-wood screen had given the most satisfactory results, you directed that this design should be first tried at Natchez.

There was a great difference in the condition of the water and banks at Natchez to that at Memphis. At Memphis we had a sand-bar and shallow water out of the main channel, and partly protected by Old Hen Island.

At Natchez we had a long, straight reach above us, and a steep bluff bank with deep water in front and exposed to the full force of the current, presenting as difficult a bank to protect as could be found on the Mississippi River.

Our first screen constructed was made of sawn lumber. Size of screen, 100 by 30 feet, made in three sections: the first, 20 feet long; second, 70 feet; third, 10 feet. Cross-pieces, 6 by 4 inches, were placed 10 feet apart, and upon these were bolted pieces, 3 by 4 feet, leaving a 3-inch water opening. The crib used for sinking this screen was 20 by 3.5 by 3.5 feet, and loaded with from 6 to 7 tons of stone ballast. This was as heavy as the means at our disposal would allow us to handle.

We sunk the screen in 60 feet of water, current about 2½ miles an hour. We had great trouble in sinking it in proper position. It remained down about 6 hours, when it parted a solid three-quarter inch chain and tore two others out of the screen. We then tried it in about 40 feet of water, when the 70-foot section broke in two. We tried various other designs, with unfavorable results. The trouble was, the screens were too wide and did not have sufficient water openings. On your inspection of the works I drew your attention to this, when you directed that the screens should be reduced to 20 feet in width and have at least two-thirds water opening. We then succeeded in constructing a screen which answered well under all circumstances to which it was applied. In the construction of this screen the material used, with the exception of bolts and wire, was obtained in the woods near the works, not from choice, but from necessity, as we were unable to obtain any sawn lumber from the Natchez mills.

For the frame-work we cut down young cypress trees and hewed them to a size of about 6 by 4 inches. We then laid down on the mattress-ways four lines of scantlings, 6 by 4 inches, 6 feet apart and 110 feet long. Upon those we placed timbers 6 by 4 inches, 10 feet apart, and securely bolted them together with one-quarter inch bolts. Upon this frame-work we placed small cotton wood or willow poles, leaving two-thirds water opening. The poles were fastened to frame by one-quarter inch bolts, and further secured by No. 12 annealed wire to the frame. We thus had a very tough and pliable screen.

The crib was built on the mattress-ways and constructed of cypress or cottonwood trees, from 5 to 7 inches in diameter. At each corner was used a white oak or hickory pin, 4 feet long and 1½ inches in diameter and 2 in the center, where a division was made, thus forming the crib into two pockets; size of crib, 20 by 3.5 by 3.5 feet.

The method adopted for sinking screens was as follows: The first screens were sunk near the shore, thus forcing the current out from bank. In securing our sinking flat out in channel we sunk 4 cribs, as shown by drawing accompanying this report, and the flat was secured to the cribs by heavy lines which held the boat in any position we desired. We then towed down a crib and lifted it about two-thirds out of water. A screen was then towed down and secured to the crib by 2¾-inch chains, when the crib was lowered to the water edge. Two barrels were secured to the lower end of screen to assist it in floating. The barrels had two cross pieces of wood placed inside over each head, and a brace between the two, to assist in withstanding the great pressure to which the barrels were subjected. The crib was loaded with stone or other ballast, placing in from 6 to 7 tons, after which the top was covered with poles and securely pinned to crib. We then secured two single lines, having a shackle and pin at the end, to two 1½-inch straps running entirely around crib; the blocks and tackle were removed and the entire weight thrown upon the the two single lines, and the crib slowly lowered to its position on the bed of the river. The pins were removed, lines drawn up, the flat-boat pulled 20 feet farther into the river by means of anchor lines, when we were ready to sink another screen. The greatest depth in which a screen was sunk was 120 feet.

We finished the work ordered considerably under the estimate, for two reasons:

1. It was intended to construct the screens of sawn lumber, but we could not obtain it, and they were constructed of material procured in the woods, free of charge except for the labor employed in getting it.

2. We were fortunate in finding stone a short distance above the works, which cost us about 50 cents per cubic yard. Should we have had to purchase it, it would have cost $3.50 per cubic yard.

After finishing the first work ordered, you directed that line No. 5 should be carried 200 feet farther into the river, making 600 feet from bank, and to construct a new line of screens, about 250 feet above line No. 5, to be carried 600 feet into the channel. This was also successfully executed, when, at your direction, work was suspended, as you considered enough had been done to thoroughly test the value of screens for bank protection.

STATEMENT OF WORK DONE.

Line No. 1: 250 feet of mattress-work, 55 by 2.5 feet; twenty-six screens sunk.

Line No. 2: 190 feet mattress-work, 55 by 2.5 feet; eighteen screens sunk.

Line No. 3: 200 feet mattress-work, 55 by 2.5 feet; twenty screens sunk.

Line No. 4: One mattress sunk, 130 by 55 by 2.5 feet; shore work unfinished because of high-water; eighteen screens sunk.

Line No. 5: 210 feet of mattress-work, 55 by 2.5 feet; twenty-nine screens sunk.

Line No. 5*a*: No mattress protection; twenty-nine screens sunk.

Length of screens if placed end to end, 3 miles. Length of cribs if placed end to end, one-half mile.

At the present time the use of screens as a protection for river banks is only in its experimental stages. I believe this is the first attempt on the Lower Mississippi in deep water. The full value of the screens can only be determined at extreme low-water when the river cuts out a low-water channel; we can then see if the lines are too near, or too far apart, and if, after the first line of works has been protected with

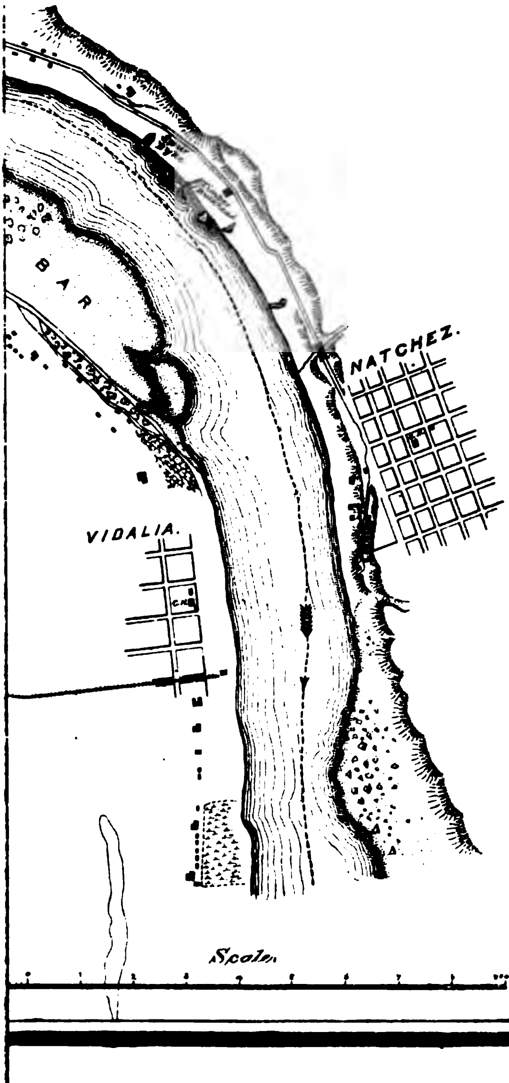
MAP OF

SSIPPI RIVER

CINITY OF NATCHEZ, MISS.

from surveys of

1879,'80 & '81.



mattress-work, it can be dispensed with on the lines below. This is important, as the mattress-work costs more than the screens, and, if it can be dispensed with, twice the length of bank can be protected at the same cost.

Up to date the work has proved very satisfactory. After the first two lines of screens had been placed, the effect on the current was remarkable. From a 2¼ or 3 mile current per hour it was reduced to one-half mile, and the drift which ran down the shore left us and kept the Louisiana side. Before we commenced, the bank was rapidly caving into the river, but up to this date we have lost no bank and all our work is standing as strong as when first completed.

Immediately below, where the bank is not protected by our work, and where the current again strikes it, it is caving rapidly. During the time we were at work the bank caved back over 250 feet.

Should the screens prove successful it will assist to solve the very difficult question of controlling the currents of the Lower Mississippi River at a comparatively small cost. The work can be done all the year round. The plant required is simple and inexpensive, and the necessary material can be obtained at a very small cost in the immediate vicinity of the works.

As to the work to be done the coming season, that can only be decided upon after the result of the recent work has been seen. It may be found that the work has not succeeded as a means of bank protection, in which case some other plan would have to be adopted; or the screens may have protected the bank, but not have changed the current, and cut the sand-bar opposite. In this event it would be best to continue the screen-work around the bend. Again, the screens may have protected the bank and caused considerable deposit in front, and changed the current so as to cut away a portion of the sand-bar opposite. In such case it would be best to extend the present works farther into the river, which I believe would entirely remove the bar and change the channel to the Louisiana shore, and form a sand-bar in front of the point in danger of being cut through.

I estimate that $100,000 can be advantageously used in improving Natchez Harbor during the next working season.

I have the honor to remain, very respectfully,

JOSEPH BURNEY.

Maj. W. H. H. BENYAURD, U. S. A.

P 4.

IMPROVEMENT OF THE MOUTH OF RED RIVER, LOUISIANA.

As no permanent plan for the improvement of the mouth of Red River had been adopted, it was decided to continue the operations, as heretofore, in attempting to keep the channel through Lower Red River open by means of the dredge-boat, assisted by a steamer and two tugs. In conjunction with these operations some 3,000 linear feet of dike were built at the Ash Cabin crossing, to retain the water in a single narrow channel.

The early reports from the parties stationed at the mouth gave such favorable accounts of the stage of water and the depths through the channel, that it was thought that there would be no great trouble for the boats to pass through from the Mississippi to the head of the Atchafalaya. The conditions were indeed very favorable; a very strong current was running through *from* the Mississippi; so strong, indeed, that it was with the greatest difficulty that the boats could stem it.

During the previous season, on the 10th of August, the gauge at the landing reading 17.9 feet above low-water, a bar was found to exist entirely across the mouth, and which was only removed by constant dredging. This past season, though, with the river almost at its lowest stage, no bar existed at the mouth, and everything was found to have been swept by the strong current down towards the Atchafalaya, and it was presumed that the greatest difficulty would be found in that vicinity. Nevertheless I had, in anticipation of trouble, invited bids from various parties to furnish me a plant, and two tugs and a steamer were held for such times as I might need their services. The weekly reports received and the examination made by myself gave me assurance that we could keep the channel open.

The effect of the current was, however, to undermine the banks and cause a continual sliding in of the soft material of which they are composed. This action continued to such an extent that finally both banks in the vicinity of the Ash Cabin, at which point we previously had the deepest water for some 400 yards in length, slid into the channel and blocked it up completely. It was not a falling or sliding in of the edge of the banks, but it seemed that the banks themselves for several hundred feet back were undermined, causing them to sink down and then slide into the partially filled and narrow channel.

The photographs which were sent to the department fully illustrated the action better than it can be described.

The condition of affairs after the sliding was worse than ever known before. Mr. Barbre, who has lived in the vicinity for upwards of fifty years, stated that he had never seen anything like it.

The filling up of the channel caused considerable embarrassment to the steamboat men, as it became necessary for them to make a transfer of their freights between Red River Landing on the Mississippi, and Barbre's Landing, at the head of the Atchafalaya. The embargo lasted, however, but a short time. A rise in the Mississippi gave soon a good navigable stage of water in Lower Old River.

It is a matter of record that on the 13th of October the fall in the water-surface from the Mississippi to the gauge at Barbre's Landing was 7.3 feet, nearly all of this fall being concentrated in the stretch between the Dead Trees and Chandler's warehouse.

While the above operations were being carried on, the observation parties were continuing the measurements and observations directed to be made by the Board of Engineers for Fortifications and on River and Harbor Improvement. The survey of Bayou Cut-off was also being made, with a view of ascertaining if a cut through from Red River to the Mississippi in the vicinity of Black Hawk Landing would not afford a solution to the vexed question of keeping open a navigable channel at all seasons of the year between the two rivers.

The reports on the above were forwarded to the department on the 15th of February, and printed in Senate Ex. Doc. No. 158, Forty-seventh Congress, first session.

During the coming season it is proposed to continue the operations of dredging, and, under the supervision of the Mississippi River Commission, to construct such works as may be necessary to check the enlargement of the Atchafalaya.

The former appropriations were as follows:

By act approved June 18, 1878	$150,000
By act approved March 3, 1879	40,000

On the 30th of June the above work was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A.

Money statement.

July 1, 1881, amount available	$126,204 64
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	35,392 24
July 1, 1882, amount available	90,812 40

COMMERCIAL STATISTICS.

As the combined commerce of the Red, Ouachita, Atchafalaya, Bœuf, Tensas, Macon, and connecting streams and bayous all passes through the mouth of Red, reference may be had to the reports on those streams.

SURVEYS OF MOUTH OF RED RIVER, LOUISIANA, AND OF GRAND BAYOU CUT-OFF.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., April 13, 1882.

SIR: I have the honor to submit herewith, in compliance with the provisions of the river and harbor act of March 3, 1881, a copy of a report to this office from Maj. W. H. H. Benyaurd, Corps of Engineers, of the results of a survey made under his direction at the mouth of Red River, Louisiana, and in the vicinity of Grand Bayou Cut-off from Black Hawk Landing on the Mississippi across the neck of land between the Red and the Mississippi rivers.

The object of this survey was a further investigation of the question of low-water navigation between the Red, Atchafalaya, and the Mississippi rivers, and in this connection to ascertain the changes in the regimen of these rivers at this locality, the survey and observations being with a view to devising a plan for the permanent improvement of the mouth of Red River, with estimates of cost. This subject has also been considered by the Mississippi River Commission during the past year. They have examined the locality and have made a report with recommendations, which is published in Senate Ex. Doc. No. 10, Forty-seventh Congress, first session.

From all the information available it appears that the changes now in progress show a continued and rapid enlargement of the Atchafalaya and a permanent connection of this river with the Red. During the extreme low-water of 1881 the lower arm of Old River, now the communication between the Red, Atchafalaya, and the Mississippi rivers, which had been broad and shallow, with flat banks to the channel, scoured out, and the banks became so steep as to cave throughout a considerable part of their length. At one period during the past year the level of the Mississippi was 7.3 feet above the level of the Atchafalaya, thus developing toward the latter a very strong current through the lower arm of Old River. It is further reported by the Mississippi River Commission that a continued diversion of larger parts of the volume of the Mississippi is apprehended, with possible injurious results to the navigation of the Lower Mississippi. The commission, in view of this, have recommended that a continuous brush sill be laid across Old River, between Turnbull's Island and the Mississippi, with the object of checking the enlargement of the outlet from the Mississippi to the Atchafalaya.

The changes now reported are for the present favorable to the navigation between the Red, Atchafalaya, and the Mississippi, and the causes of these changes may aid in the solution of the question of maintaining a low-water channel between the two rivers. In fact, it appears that the Atchafalaya receives not only all or nearly all of the water of the Red, but a large volume from the Mississippi, and probably will, if left to itself, continue to enlarge. It now affords the line of least resistance for the flow of the Red to the sea, the distance to the Gulf by the Atchafalaya being only about one-half the distance to the mouth of South Pass of the Mississippi River.

Several plans proposed for effecting a permanent improvement of the mouth of Red River were discussed in the report of the Board of Engineers published in Senate Ex. Doc. No. 168, Forty-sixth Congress, second session, to which attention is invited.

The survey at Grand Bayou Cut-off, now reported on by Major Benyaurd, was made to determine the practicability of turning the Red River into the Mississippi at this locality by a cut across the neck of land from near mouth of Bayou Cocodrie to a point near Black Hawk Landing on the Mississippi River. Major Benyaurd reports that the lowest water in the Red River at this point in 1881 was 3.3 feet below the lowest water known in the Mississippi, that of 1872, and that during the recent survey this difference of level varied from 3.9 feet to 7.8 feet, the water of Red River being below that of the Mississippi. The average duration of the low-water season in the Red is about twice the length of that in the Mississippi. It is certain that an open cut through which a connection between the Red and Mississippi could be made at this place would not give anything more than a high-water channel, and the waters of the Red, in the usual relative low-water condition of the two rivers, can only be made to flow into the Mississippi by damming up the Red below the proposed cut. This might, and probably would, result in deposits in the river above the dam sufficient to produce obstructions to navigation similar to the obstructions in the lower arm of Old River. Such a dam for closing the channel of Red River may be built so as to cut off entirely the flow down Red River at extreme high-water, or only to about bank height, leaving the flood to go over the banks and the crest of the dam. In the first case an extensive line of levees would have to be built in order to prevent the flood from gaining the Atchafalaya by a westerly route.

The lowest estimate presented by Major Benyaurd for making a connection between the Red and the Mississippi at this point is $824,255. This is without the necessary levees and does not include anything for purchase of land for the site of the work, or for damages by overflow.

The great cost of this plan, the results of which will be uncertain, and the ever-recurring expenditure for keeping the channel open should be considered before the plan is adopted. The plan is not now recommended.

The plans heretofore presented may be briefly stated as follows:

I. To separate the Red and Atchafalaya by a low-water dam, thus forcing the former to flow into the Mississippi through Upper Old River and a cut across the point east of Turnbull's Island.

The effect of this would be only to transfer the difficulties from the lower to the upper channel at a considerable expense. The causes that operate at the present time to fill up the narrow water-way of Lower Old River would operate in the same manner with the upper channel.

II. The second plan referred to proposes to open a new connection between the Red River and the Mississippi by way of the Atchafalaya, Grand River, and Old Bayou Plaquemine, the mouth of Old River to be closed, or the three rivers left as at present.

This plan involves the construction of locks at Plaquemine having a lift of 30 feet and a total estimated cost of at least $554,000. The actual cost would probably far exceed this estimate.

Objections are raised to closing Old River on account of overflow, which would result from high-water in the Mississippi, or in the Red, since Old River serves to carry off surplus water from one river or the other, depending on the relative stage of the two. Claims for damages would, of course, result from any overflow in either case.

Another plan now referred to by Major Benyaurd, and at one time recommended by the State engineer of Louisiana, is to close the Atchafalaya and force the Red to become a tributary to the Mississippi. This would involve the flooding of the surrounding country at high-water.

It is possible that the enlargement of the cross-section of the Atchafalaya may be prevented by laying a mattress sill across its bed near to or below the head of this river; and in case that it is found necessary to connect the Red, Atchafalaya, and the Mississippi by means of a canal and lift lock, in order to secure a navigable channel at low-water, that a suitable locality may be found above the mouth of the Red when the difference of level will be much less than that at Plaquemine.

A further investigation of this question is proposed, and observations and measurements will be continued in order to determine the most practicable plan for improvement of navigation at this locality. At present none of the various plans suggested can be confidently recommended.

There is also submitted herewith—

1. Map of Lower Red River from Echo Landing to the Mississippi River, including adjacent country.
2. Sketch showing the connection between Red River and the Mississippi by way of the Atchafalaya, Grand River, and Old Bayou Plaquemine.

Very respectfully, your obedient servant,

H. G. WRIGHT,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

Hon. ROBERT T. LINCOLN,
Secretary of War.

REPORT OF MAJOR W. H. H. BENYAURD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., February 15, 1882.

GENERAL: I have the honor to transmit herewith the following report of the surveys of the mouth of Red River, Louisiana, and of Grand Bayou Cut-off, with a view of considering the plans presented for keeping open permanently the low-water communication between the Mississippi and the Red and Atchafalaya rivers.

The river and harbor act of March 3 last provided for the survey of the mouth of the Red, and in connection therewith I was directed by the department, under date of May 5, at the request of Hon. B. F. Jonas and Hon. E. John Ellis, whose letter will be found annexed, to make a survey of the cut-off at Grand Bayou, as projects had at various times been considered by former State engineers of Louisiana looking to the improvement of that locality as an outlet for Red River, and which it was thought would afford a solution to the problem. The recommendations of the Board of Engineers for Fortifications and for River and Harbor Improvement, to whom the former report had been submitted, that certain observations and measurements be made, were also carried out during the past two low-water seasons. The results of the surveys and observations will be found in the accompanying reports.

SURVEY OF GRAND BAYOU CUT-OFF.

While the distance from the Mississippi to the Red is but 3.4 miles at this point, it was necessary to extend the survey up the Red some 40 miles to a point above the head of Long Lake, thence to and along the Bayou de Glaise and the Avoyelles Prairies to the town of Marksville, with cross-lines, so as to embrace that entire section. This was done in order to determine what effect the opening of the outlet and the damming of Red River below would have on the surrounding country, and what additional works would be necessary. From the mouth of the Cocodrie, where Bayou Cut-off enters Red River, the survey was continued southward to the head of the Atchafalaya, connecting with the work at Old River. The Mississippi River, for several miles along the front in the vicinity of the bayou, was also included in the operations, and cross-lines run to determine the best location for the proposed opening. The report of Mr. Burrowes will give in full the various operations and details of this survey.

The following are the main points of information derived from the survey necessary to be considered in the contemplated improvement.

Bayou Cut-off, which, as a narrow, crooked channel, formerly connected the Mississippi and the Red, is now almost completely blocked with timber growth, and is closed at its head by a substantial levee. Its average width is about 150 feet. An immense sand-bar has been formed in the Mississippi directly in front and extending southward to a point about 1½ miles below.

The average fall of the land surface from the Mississippi to the Red, taken from the sections run, is about 10 feet.

The lowest water known in the Mississippi is that of 1872; in Red that of 1881. Taking these two years as the extremes, the difference in the low-water level of the two streams at Bayou Cut-off was found to be 3.30 feet. This difference, however, is very variable and usually much greater. During the progress of the surveys the gauge records show that the difference in level varied from 3.9 on August 9 to 7.8 feet on September 30.

The Red at Alexandria reached a stage on September 29, 3.7 below the zero of the gauge. This is the lowest ever known, being 1.1 feet below the low-water of 1872 at that point.

On September 2 the fall of the water surface from the mouth of the Black to the mouth of the Cocodrie, a distance of 12½ miles, was 0.45 of a foot; the fall from the Cocodrie to the head of the Atchafalaya, 15¼ miles, was on the same day 0.60 of a foot. The greatest slope between the mouth of the Cocodrie and the Atchafalaya was found to be on the 18th of September, when the water had fallen at Barbre's, reaching a stage 1.20 feet below the zero of the gauge at that place, and at Cocodrie it had fallen 1.6 feet, making the extreme slope between the two places 1.5 feet.

In comparison with the small slope found in the Lower Red, September 2, there was found to be in the first 8 miles in Red River above the mouth of the Black, on the same day, a difference of level of 6.4 feet.

The high-water slope of 1881, between the mouth of the Black and the head of the Atchafalaya, was found to be 4 feet.

In this matter of the water-levels, it may be well to insert here, to be alluded to hereafter, the references at the head of the Atchafalaya. The lowest water ever known at that point occurred on September 18, at which time the water surface had fallen at Barbre's 1.20 feet below the zero of that gauge. This zero is 0.3 of a foot above the zero of the gauge at Red River Landing, which corresponds to the low-water of 1872. According to the connections made with the bench-marks of the Coast and Geodetic Survey, this would bring the extreme low-water mark at the head of the Atchafalaya 1.86 feet above the mean level of the Gulf.

In the plan in question it is proposed to make a cut from the Mississippi to the Red in the vicinity of Black Hawk Landing with a view of bringing the latter stream out into the Mississippi at that point. A reference to the levels above referred to will show that in the exceptional case of the stage of water in the Red being higher than that in the Mississippi, the latter will flow in and seek the lower levels of the Atchafalaya. An inspection of the gauge records for the past eleven years at Alexandria and at Red River Landing shows that at an assumed stage of low-water in each stream, the average duration of the low-water season in the Red is about twice the length of that in the Mississippi, and that, though a rise has occasionally occurred in the Red, it has not lasted entirely through the low-water season, nor sufficiently long to affect the general conclusion above stated. It is doubtful if the passage through which the connection would be made would give anything more than a high-water channel.

If the waters of Red were closed below the outlet by a dam, the water (in the usual relative low-water condition of the two rivers) in the Red would be held until sufficient head was obtained to allow the surplus to flow into the Mississippi. Taking into account the sedimentary character of the two streams, the check in the flow caused by the dam would in nearly all cases produce a deposit sufficient to cause obstructions to navigation, and mechanical devices would have to be resorted to in order to remove the same, as is now done at the present mouth of Red. It might occasionally happen that the rise in Red would have sufficient velocity to carry out these deposits, but the exception would only be at long intervals.

The dam for closing the channel of Red River may be built so as to cut off entirely the flow down Red River at extreme high-water, or only to about bank height, leaving the flood to go over the crest of same.

In the first instance, as the whole country to the west is annually inundated by high-water, either from flood in the Red alone or by a combination of floods in both the Red and the Mississippi, an extensive line of levees would have to be built in order to prevent the flood from gaining the Atchafalaya by a westerly route. The line might be run directly from the dam westerly to the Avoyelles Prairies, or along the bank of the Red northerly until the high land is reached in the vicinity of Choctaw Bayou. The estimates for the latter are much less than in the former. The various bayous, like the Allemands, the Choctaw, the Rouge, the Lenoir, Grande River, the Avoyelles, and Lake Long, all drain into Red River at low-water, but they take water from it at high-water. All this water escaping below the Choctaw, reaches the bank of the De Glaise about the Big Bend, runs into it along its eastern side, and overflows all the country between this stream and the Red, and finally escapes into the Atchafalaya above the mouth of the De Glaise, or into Red River above. With the present plan of closing the river by a high-water dam and levees, if the bayous above the Choctaw high lands were not effectually closed, the surplus water would find its way to the Atchafalaya to the west of the De Glaise, and to the Teche by way of the Bœuf.

I believe this plan was the one considered by Louis Hebert when

State engineer, in 1858, and the one alluded to in the letter of Hon. Mr. Jonas and Hon. Mr. Ellis. He presented no estimate for the work, as he declared the plan *utterly impracticable*. It was first brought forward by George T. Dunbar, when State engineer, in 1839. Though I have never been able to find his report, or his full plan, I found that the estimated cost was placed at $2,000,000. Mr. J. K. Duncan, in 1860, when making his report on the Plaquemine route, merely alluded to the Bayou Cut-off as an auxiliary work, proposing to make communication to the Red River region by means of similar slackwater navigation. His estimate for the excavation was $646,775.50, and for the lock $221,333.50, a total of $868,109; no levees or other auxiliary work being needed.

In connection with plan for outlet without extreme high-water dam and levees, a dam across Long Lake is included to prevent a discharge from Red at that point, where otherwise a discharge takes place at a moderate stage in Red.

The following are the estimates for the plan of opening Bayou Cut-off as above:

Outlet along line No. 1, with extreme high-water dam and levee, up right bank of Red River, to Marksville Prairie	$1,217,767 85
Outlet along line No. 1, with extreme high-water dam and levee, by way of Bayou de Glaise, to Marksville Prairie	1,248,986 05
Outlet along line No. 2, with extreme high-water dam and levee, up right bank of Red River, to Marksville Prairie	1,130,079 50
Outlet along line No. 2, with extreme high-water dam and levee, by way of Bayou de Glaise, to Marksville Prairie	1,161,297 70
Outlet without levee along line No. 1	911,943 30
Outlet without levee along line No. 2	824,254 95

For details of the above estimates see accompanying report.

In addition to the estimates for actual work there must be added the amounts which must be paid to individuals for land, &c., taken for the proper execution of the plans.

In the plan with a bank-height dam the high-water conditions remain as at present, and as set forth in previous communications on this subject. It, however, alters the low-water condition at the present mouth of Red, and introduces new elements into the problem at that locality. As all water at a low stage is cut off from the Atchafalaya, that stream must derive its volume from the Mississippi through Old River. With the constant increase in the section of the Atchafalaya an increased volume of water will be drawn from the Mississippi, which will tend to enlarge the narrow sections of Old River and keep that channel open during the season of low-water. The effect of such an increasing outlet upon the navigation of the main river, in my opinion, cannot be otherwise than detrimental.

The estimates herewith attached are for the excavation of a cut from the Mississippi to the Red, taken at 100 feet on the bottom. This was the smallest width that it seems desirable to take, considering the size of the boats. The excavation required is so great that any increase beyond that width greatly adds to the cost.

For the extreme high-water dam and levees the estimates are for a dam with base of 520 feet, and for levees with a crown of 14 feet and slopes 2½ to 1 foot.

For the bank-height dam the estimates are for a brush construction with base of 440 feet. The bottom, on account of the nature of the soil, is protected by a mattress apron 900 feet below, and the banks on either side are protected up to the top for a distance of 900 feet above and below the dam, all covered with a heavy ballast of stone.

The great cost of this plan, with the difficulties and uncertainties, together with the cost also of keeping the channel open, combine to render any plan for an opening at Bayou Cut-off impracticable.

SURVEYS AND OBSERVATIONS AT THE MOUTH OF RED.

The surveys at the mouth of Red were continued during the seasons of 1880 and 1881. The report of the former year will be found in Appendix P of the Report of the Chief of Engineers for 1881; that for the past season will be found annexed, together with the maps referring to both years. In the latter case it was merely necessary to have the lines and sections of the previous surveys accurately re-run and the necessary comparisons made.

The survey of 1880 shows that as a general thing a fill took place in the channel of Lower Old River from the Mississippi to the Atchafalaya, and that the Atchafalaya continued to increase throughout.

At the mouth of Old River (Mississippi) on the 10th of August, 1880, with the gauge at Red River Landing reading 17 feet above low-water (1872), a bar was found stretched entirely across the mouth, through which a channel had to be maintained with the dredge; the position of this cut is shown on Rees's map. The lowest reading observed on the Red River Landing gauge was 6.1 feet on October 26, and at Barbre's 5.0 feet on October 27. In the channel through Lower Old River the bars were being built up, and becoming more bluff on the edges, confining the water to a narrower channel, which would tend to deepen the same. The bar which had previously existed at "the Gut" was found to have moved towards the Atchafalaya. During the season of low-water, extending over three months, the current flowed towards the Mississippi fifty-six days, flowed towards the Atchafalaya fifty-six days, and during thirteen days showed no appreciable current either way. These conditions were not very favorable for keeping the channel open except by constant dredging. A fill occurred throughout the entire channel compared with the results of the survey of 1878-'79.

During the season of 1881 the survey shows that the condition of affairs was very materially changed. There was a constant current from the Mississippi towards the Atchafalaya, which has continued to the present date. At the mouth the bar alluded to as existing in 1880 was found to have been swept entirely away, and though the Mississippi reached a stage at the landing 3.4 above the low-water of 1872, a depth sufficient for all purposes of navigation was found directly through the middle of the channel at that point.

A very decided increase was found in the sections of the Atchafalaya, compared with the previous surveys, except in the first section, at the head, where formerly a deep hole existed, caused by the eddy formed by the union of the waters from the Mississippi and from the Red. This increase of section throughout the Atchafalaya was found to have taken place in the low-water sections, and amounted to an average of about 1,100 square feet per section. The condition of the banks late in the season showed that considerable caving had been taking place.

In Old River this last survey showed also a decided scour, varying from 4 to 11 feet in the channel proper, from the Mississippi through to the head of the Atchafalaya, while to some extent the bars have been built up, rendering them more bluff on the edges. As observed before, the current was from the Mississippi. The lowest observed reading on the gauge at the landing was 3.4 on the 21st of September. The same day at Barbre's it was 0.8 of a foot below the zero of the gauge. The lowest observed reading at that place was on September 18, when the water fell to 1.20 feet below the zero. About this time the Mississippi commenced rising, the Red remaining low, and the difference in the two gauges reached 7.3 feet on the 13th of October. This great fall was mostly concentrated in the stretch between the Ash Cabin and the Atchafalaya, and caused the scour above alluded to. So strong was this current in the earlier stages that no boat coming out was able to stem it without assistance from our fleet. This scour became so great that the banks were unable to stand, and finally for several miles on both sides of the channel, extending from a point above the Ash Cabin to Chandler's, the whole mass slid into the channel and blocked it up. Had the rise not continued, it is probable that the channel would have remained closed for a longer period than it did, though the dredge and tugs were kept constantly at work.

The results of the surveys of the past three years show conclusively that the Atchafalaya is gradually increasing in size, which, if continued, will lead eventually to the absorption of the Red. The survey of the past year shows in addition a decided scour through Lower Old River, with a lowering of the low-water line at the head of the Atchafalaya. Should these influences continue, the tendency will be towards a continued influx from the Mississippi, the scouring effect of which, aided by the annual work of dredging, will tend to keep the channel open, retarded only by the sliding in and caving of the newly made banks of Lower Old River. In the Mississippi, above the mouth of the Red, in the vicinity of Carr's Point, the banks are caving quite rapidly, a continuation of which down stream will eventually throw the current from the Mississippi more directly in the mouth of Old River. All these causes may aid in the solution of the question of maintaining a low-water channel open through from the Mississippi to the Atchafalaya. The danger may be, however, that the enlargement of these channels will take so large a volume of water from the Mississippi as to injure the navigation of that stream, and call for work to prevent the further enlargement of that stream. I do not think that this danger in unfounded after the experience of last season, when the relative stages of the water of the Mississippi and the Red were such, when combined with the dredging, as to have produced the scour and depth of channel in Lower Old River. The observations and measurements, however, which will be continued, will throw additional light on this question.

On the other hand, should the changes alluded to above not take place, leaving the channel-way in the condition it has been for several years, with the current alternating in or out, according to the relative stages in the Mississippi and Red, dredging or operations of a like nature will have to be resorted to to keep the channel open temporarily.

The only plan that has been considered heretofore for a permanent improvement to be applied to the immediate locality is that of closing Old River at the head of Turnbull's Island, and forcing Red down Upper Old River, thence by a canal out into the Mississippi at or near Carr's Point. This was considered and reported upon adversely by the Board of Engineers. In its outlines it is like the Bayou Cut-off route, with the advantage of being more economical in carrying out. According to the survey of 1878, the bottom of *Upper Old River* averaged about 5 feet above Lower Old River. The cutting out of the latter and the silting up of the former has increased this difference of level to about an average of 10 feet.

I must say that I can recommend no suitable project for the *permanent* improvement of the mouth of Red, to be applied to that particular locality.

One plan advanced before the war by Louis Hebert, when State engineer, was to close the Atchafalaya in the vicinity of Simmsport, or at some point below the De Glaise, and force the Red to become a tributary to the Mississippi. This would cut off the whole region of rich country below from any water communication with the Mississippi, and would call for additional work throughout Lower Red River Valley and along the Mississippi. No intelligent discussion of this plan could be made without the results of survey, extending over some hundreds of miles, so as to embrace the surrounding country and the rivers likely to be affected by the work necessary to affect a closure of that important stream.

Accompanying this report are the following maps and plates:

Map of survey of Bayou Cut-off (tracings), 7 sheets.
Profiles and sections of Bayou Cut-off, 1 roll.
Maps of survey of mouth of Red River (tracings), 2 sheets.
Sections of survey of mouth of Red River, 1 roll.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

LETTER OF THE HON. B. F. JONAS AND THE HON. E. JOHN ELLIS.

WASHINGTON, D. C., *May* 2, 1881.

GENERAL: At the last session of the Forty-sixth Congress, in the bill making appropriations for the improvement of certain rivers and harbors, a clause was inserted directing the Chief of Engineers to cause an accurate survey of the mouth of Red River, in Louisiana, to be made, and a plan reported, with estimate and cost, for its permanent improvement.

The danger that seriously threatens the mouth of Red River is, as is well known, that the Atchafalaya River, which deflects from Red River at a point about 5 miles from the junction of the Red with the Mississippi, is rapidly widening and deepening, and is gradually absorbing the entire volume of water that flows down Red River. Between said point of deflection of the Atchafalaya and the mouth of Red River a serious bar has formed, through which a channel for navigation is kept open only by constant dredging. Unless this state of affairs be remedied speedily, Red River will cease to flow into the Mississippi, and the mouth of the Atchafalaya will become the mouth of Red River.

This subject was seriously considered before the war by the authorities of Louisiana, and after a survey the State engineers recommended the opening of Cut-off Bayou, a large and deep bayou which is some 4 miles in length, and, beginning near the Mississippi River, flows westwardly into Red River at a point 18 miles above the mouth of that river. The opening of this bayou, coupled with a dam at some point on Red River below the mouth of the bayou, it was thought, would force Red River through the channel at Bayou Cut-off, and thus establish for it a junction with the Mississippi some 14 miles above the present point of junction.

So favorably was this plan considered that the Louisiana legislature appropriated a sum of money to carry it into execution, but the occurrence of the civil war prevented.

We beg to submit a map showing the position of the present mouth of Red River, the Atchafalaya, the bar, and also the Cut-off Bayou.

We regard the plan of opening "Cut-off Bayou" as of sufficient importance to make it our duty to suggest it, that it may be considered along with such other plans and theories as may engage the attention of the engineers in charge of this most important work.

With great respect, we are, your obedient servants,

B. F. JONAS, U. S. S.,
E. JOHN ELLIS, Member Congress,
Louisiana.

Maj. Gen. WRIGHT, U. S. A.,
Chief of Engineers.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
May 5, 1881.

Respectfully referred to Maj. W. H. H. Benyaurd, Corps of Engineers, for consideration and report in connection with the survey and report provided for in the river and harbor act of March 3, 1881.

By command of Brigadier-General Wright.

JOHN G. PARKE,
Lieutenant-Colonel of Engineers,
Bvt. Maj. Gen., U. S. A.

GRAND BAYOU CUT-OFF.

REPORT OF MR. F. S. BURROWES, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., —, ———.

MAJOR: I have the honor to submit the following report of the results of the survey of Grand Cut-off Bayou, Louisiana, accompanied by maps, profiles, and sections, and estimates of cost of suggested improvement.

The object of the survey, as conveyed in your verbal instructions, was to make a thorough examination of the neck of land between the Mississippi and Red rivers, along and near Grand Cut-off Bayou, so as to be able to determine upon the feasibility and probable cost of making a new mouth for Red River near that point. You also ordered as much as possible of the adjacent portion of Red River to be surveyed, so as to be able to judge what effect the making of such an outlet would have upon the adjoining bottom lands.

In obedience to these instructions I left this place early in July last, and arrived at Black Hawk Landing on the 16th of the same month, accompanied by the following party: William Shelton, levelman; J. Jay Smith, recorder; a rodman, a cook, and four skiffmen. The personnel of the party remained the same, with the exception of rodmen and skiffmen, throughout the survey.

These last left and had to be replaced several times during the period we were in the field, on account of attacks from prevailing fevers, from which the whole party suffered considerably.

Three men I know of died soon after leaving the party on account of sickness. This of course delayed the work to some extent, as it was almost impossible to secure new men immediately in that locality. With this exception the survey moved along smoothly and satisfactorily.

LOCATION OF GRAND CUT-OFF BAYOU.

Grand Cut-off Bayou is a deep, crooked ditch about 150 feet wide, through which the waters of Mississippi and Red rivers used to mingle at a medium high stage. A dam or levee across its Mississippi end now severs this connection. It is situated in the parish of Concordia, La., about 16 miles above the present mouth of Red River. Black Hawk Landing, on the Mississippi, is about 2 miles below the cut-off. I encamped at this point, and remained there until I had finished the survey connecting the two rivers. During the further progress of the work camp was moved by skiff and steamboat from point to point on Red River, so as to be conveniently situated for its prosecution.

EXTENT OF AND MANNER OF MAKING SURVEY.

Starting at a point on the bank of the Mississippi River about one mile below Black Hawk Landing, a meandering transit line was run up to and thence along Grand Cut-off Bayou and Bayou Cocodrie to Red River. Two other lines (marked on the map line No. 1 and line No. 2, respectively) were then run out, joining the two rivers south of the cut-off. Points were located to determine the extent of the sand bar above Black Hawk Landing; a stadia line from the cut-off was run 1 mile farther up old bank of the Mississippi; soundings taken in front of and below Black Hawk Landing, and the survey connected with a triangulation station of the Coast and Geodetic Survey.

Lines of checked levels accompanied all of this portion of the survey, the distances in which were obtained by chain measurement and checked by calculation.

A water gauge was established in the Mississippi River at Black Hawk Landing, and daily readings taken thereon while the party was in the vicinity. A record was also kept of the stage of water in Red River at mouth of Bayou Cocodrie during the months of August and September.

Red River was then surveyed for a distance of 40 miles connecting at its lower end with survey of the mouth made by Mr. W. M. Rees in 1880. The method of making the river survey was the ordinary one of locating points by trangulation and filling in blank lines between by stadia measurements.

A stream of the character of this portion of Red River (narrow and crooked, with heavily-timbered banks) offers great obstacles to the making of an accurate trigonometrical survey of its course, as, with a party unable to use much time clearing lines, the triangles will necessarily be distorted in shape. Considering the instruments used (the ordinary field transit) and the rapidity with which the work was done, the results obtained were very satisfactory. The base lines were carefully measured with a steel tape, the distances between check bases being from 12 to 15 miles, and the discrepancies between their calculated and measured lengths were very little over 1 foot. A line of ordinary levels accompanied the whole of the triangulation, in order to arrive at the slope of the water surface and the general height of the banks. Cross-sections of the river were sounded at frequent intervals and the line of deepest water thus determined.

In order to arrive at the width of the swamps between Red River and the highlands, or prairie, on which is situated the town of Marksville, a meandering transit line was run from Marcotte Landing back to and along the Bayou De Glaise and the prairie to within 2 miles of the town of Marksville, a distance of 26 miles. The distances along this line were obtained by stadia measurements, and, on comparison, were found to agree closely with the sectional map of Avoyelles Parish. A line of levels accompanied the above stadia line across the swamp from Marcotte Landing to Bayou De Glaise, a distance of 7 miles.

The base of levels assumed for the entire survey is the elevation of lowest water of 1881 in Red River at mouth of Bayou Cocodrie, and reads 0.20 of a foot on gauge at Barbre's Landing. The elevation of bench-mark of Coast and Geodetic Survey at Black Hawk Landing above this base is 48.745 feet.

This survey will not furnish all the data it would be well to have in order to determine the cost and effect of the suggested plan of improvement; but as an exhaustive one would include, perhaps, a hundred more miles of river (a distance it would have been impossible to get over with my party in one season), the work was confined to what was judged to be the section of country having the most direct bearing on the discussion of this scheme.

DESCRIPTION OF SURVEYED PORTION OF RED RIVER.

From the head of Turnbull's Island to the end of the survey the river has been practically abandoned for agricultural purposes, there being at present only two points in reach at which crops are made. The first is a narrow strip of cleared land, following the south bank of Grand Cut-off Bayou and Bayou Cocodrie to Red River, and the other is a plantation containing 200 acres, 2 miles above the mouth of Black River. Other smaller pieces of land at, and a short distance below, the mouth of Black River have been cleared and cultivated for a time, but overflows and sickness have driven the settlers out of the country and allowed their places to grow up in thicket. The banks along this portion vary in height from 37 to 47 feet above low-water, are all below high-water mark, and entirely unprotected by levees. They are heavily covered with a thick undergrowth and timber common to that portion of Louisiana, being principally willow, bitter pecan, ash, honey-locust, white and other varieties of oak, cypress, persimmon, hackberry, and sycamore. This timber is valuable chiefly for fuel. Several yards are maintained near the mouth of Black River which get out cord-wood, principally ash, for steamboat use. The cypress and other timber fit for dimension lumber has been pretty thoroughly culled out. The character of the bed and banks is similar to other portions of the alluvial bottom, consisting of a substratum of blue clay and a layer of sand some 15 feet in thickness, covered with sedimentary deposit.

The banks of the river were found to be very unstable, especially during the lowest stage of water. The manner of their movement was almost universally of the nature of a slide. In most cases the layer of sand seemed to have advanced bodily towards the river, apparently slipping on the substratum of clay, and in many places the effect of these slides extended back several hundred feet.

BAYOU DE GLAISE.

Marcotte Landing, the point from which the Bayou De Glaise line was started, is situated on an elevated piece of ground, commonly known as Rabbit Island, 8 miles above the head of the Atchafalaya River. A road leads from here across the swamp and meets Bayou De Glaise about the middle of the Big Bend. This road is good during the dry season, thus making Marcotte Landing a shipping point for the Big Bend during low-water. Two thousand bales of cotton have been shipped and the necessary supplies received at this point during a season.

The portion of Bayou De Glaise along which the line was run (being the upper half of the Big Bend) was found to be practically dry during extreme low-water. A strip of highly cultivated land, varying in width from three-fourths to one and a half miles, follows the bayou throughout this distance. More than two-thirds of this cleared strip is on the south side of the bayou, and has been protected by a levee running along the right bank. This levee is at present badly in need of repair, and should be raised several feet throughout its entire length to keep out floods such as that of 1874, which flowed over it in many places.

The left bank is almost entirely submerged at times of very high-water.

Boats navigate the bayou during medium high-water, but for seven or eight months in the year the products of the country are shipped, and supplies received, either at Marcotte or Water Valley landing on Red River, or by way of the Cut-off road at Big Bend Landing, or Simmsport on the Atchafalaya.

The survey line left the bayou about 2 miles below Moreauville, and ran 3 miles across the swamp to Marksville Prairie, along the edge of which it followed to a point nearly opposite the town of Marksville. This prairie is about 20 feet above high-water, and is cultivated throughout almost its entire extent. Its yield per acre is not nearly so large as that of the bottom lands along Bayou De Glaise, but its freedom from overflow makes it desirable farming and grazing property. Its shipping points are Ware's, Barbin's, and other landings on Red River.

The unreclaimed bottom lands included between Red River, Bayou De Glaise, and Marksville Hills, are utilized only as an immense range for stock owned by people residing on the prairie and along the bayou. The natural increase makes this ordinarily a profitable business, but some years floods come so rapidly down Red River that it is impossible to get the stock to a place of safety, and much of it is lost.

LAKE LONG.

The distance across the swamp from Red River, below mouth of Bayou Cocodrie, to Marksville Prairie is 21 miles, as determined by the survey. About through the center of this swamp runs Lake Long, a wide, lake-like bayou. Throughout most of its length it is from 600 to 800 feet in width, and is connected at either end with Red River. Below it empties through Bayou Natchitoches, 4 miles below the mouth of Bayou Cocodrie, and at its upper extremity has two openings into Red River (known as Lake Saint Agnes and head of Lake Long), which are situated in the center of a sharp left-hand bend, 12 miles above the mouth of Black River. Although at low-water its channel is nearly dry, at a medium high stage it becomes a side chute for Upper Red River, through which much of the water pours, seeking this shorter route. I was told by steamboat-men, and others, that at times it affects the river at its upper extremity to such an extent as to induce a current from both directions towards its head. It seems at least to be pretty well established that at certain stages the strongest current is through this channel, as drift and other *débris* coming from the upper river follows its course, coming out into the river again through Bayou Natchitoches. Steamboats also have been known to navigate its entire length.

From this it will be seen that any plan of changing the mouth of Red River to a point above the mouth of Bayou Natchitoches must necessarily include some method of preventing Lake Long from becoming the permanent main channel for Upper Red River.

SLOPE OF RED RIVER.

On the 29th of September last Red River reached a stage at Alexandria which read 3.70 feet on the gauge at that point, being 0.60 of a foot below the lowest water previously recorded, that of 1879. A comparison of the gauge readings at Alexandria and those taken at mouth of Bayou Cocodrie during August and September last (see Table No. 1) shows an increase in the slope of Red River between these points of 15 feet from August 3 to September 14. This increase was discovered by the levels to have been entirely absorbed in the river above the mouth of Black, as the following data will show. The slope between the mouth of Bayou Cocodrie and the mouth of Black River, a distance of 12½ miles, was determined by the levels to be, on September 2, 0.45 of a foot, or 0.036 of a foot per mile. The slope from mouth of Bayou Cocodrie to head of Atchafalaya (a distance of 15½ miles) was on the same day, as shown by a comparison of the gauges (see Table No. 2), 0.60 of a foot, or 0.0387 of a foot per mile, making the total slope from head of the Atchafalaya to mouth of Black River (a distance of 28 miles) 1.05 feet, or 0.0375 of a foot per mile. At the same time there was found in the first 8 miles of Red River above the mouth of Black a difference in level of 6.40 feet, or 0.80 of a foot per mile. As a result of this greatly increased fall there was a current in this portion against which steamboats were hardly able to make headway without the aid of shore lines. These slopes constantly change, as is shown by a comparison of the gauge readings at mouth of Bayou Cocodrie and the head of the Atchafalaya (or Barbre's Landing) during the months of August and September last (see Table No. 2), during which time the difference in level varied from 0.20 of a foot to 1.30 feet. The slope from the mouth of Black River to the head of the Atchafalaya during the high-water of 1881 was found from the water-marks to have been 4 feet, or 0.1429 of a foot per mile. In the determination of all these slopes, elevations of water surface and marks were taken at intervals of 1 or 2 miles and found to agree with rate of fall as obtained for total distance, showing that no considerable error in the levels could have occurred.

DESCRIPTION OF GRAND CUT-OFF BAYOU AND VICINITY.

Before describing in detail the Grand Cut-off Bayou and the adjoining strip of land between Mississippi and Red rivers, I have thought it best to lay before you all the information obtainable from the remainder of the survey, so as to be able to show more clearly the different factors involved in making an outlet at this point.

The Cut-off, as before stated, is a deep, crooked ditch, 150 feet wide, which starts from old bank of Mississippi and enters Bayou Cocodrie about 1,000 feet from its confluence with Red River, making the distance between the two rivers along its course 16,700 feet.

Bayou Cocodrie, into which it flows, drains the country between the Mississippi and Red Rivers north of the Cut-off, and at times of high-water connects with Lake Concordia near Vidalia. A mere cursory examination of the Grand Cut-off Bayou seemed to show that it could not be economically used as an outlet, for the following reasons: A sand bar has formed and is continually enlarging in front of its Mississippi end, its course is so crooked that but a small portion of its length could be utilized in making a navigable channel, and the land along its banks is the highest in the vicinity (see profile of south bank herewith submitted). The survey confirmed these impressions to such an extent that it will not be treated in detail as a possible location for an outlet.

OSCILLATION AND DIFFERENCES IN WATER LEVELS.

The highest water at this point both in the Mississippi and in Red River of which any record was obtainable occurred in 1874. The lowest water occurred in the Mississippi in 1872, and in Red River in 1881. These years are therefore used in determining the oscillation. The difference in level in Red River at mouth of Bayou Cocodrie between low-water of 1881 and high-water of 1874 was ascertained to be 51.10 feet, and in the Mississippi, at Black Hawk Landing, between low-water of 1872 and high-water of 1874, about 47.80 feet. The elevation of high-water of 1874 at either end of the Cut-off was found to be the same. The levees were broken at that time and the country atmost entirely submerged from Grand Cut-off to present mouth of Red River, thus making the two rivers practically one stream between these points. Subtracting 47.8 feet, the oscillation in the Mississippi, from 51.10 feet, the oscillation in Red River, we get 3.30 feet as the difference in level between the lowest water in each river; that is, low-water of 1872 in Mississippi River at Black Hawk Landing was 3.30 feet above low-water of 1881 in Red River at mouth of Bayou Cocodrie. The difference in level is, however, often much greater, as is proven by an examination of table of gauge readings at Black Hawk Landing and mouth of Bayou Cocodrie for months of August and September, 1881 (herewith attached and marked Table No. 3). This shows that the height of the Mississippi above Red River varied from 3.90 feet on August 9 to 7.80 feet on September 30.

During the high-water of 1881 the surface of water in Mississippi at end of Cut-off was 2.10 feet above surface of water in Red River opposite, and at a point 3 miles below the difference in the same direction was only 1.80 feet. During this flood the land between the rivers was not entirely submerged, thus allowing each to assume an independent slope. The elevations of flood heights were taken from marks on the timber, being the only records obtainable.

In making estimates of cost of turning Red River out at this point, two plans will be considered.

HIGH-WATER OUTLET.

The first contemplates making it the permanent and only mouth of Red River for all stages of water, and would include, besides the cutting of a canal, the building of a dam across Red River, reaching above high-water mark, and connected by levees of same height both with the Mississippi and with a point far enough up Red River to prevent the water from escaping around it and finding another outlet to the Atchafalaya. The estimates submitted for this plan include only a length of levee sufficient to connect the dam with the Marksville Prairie by either one of the two following routes:

The first follows closely up the right bank of the river to a point near Fort De Russy, and has a total length of 29.3 miles. The second follows down the right bank 25,600 feet, then runs across swamp 29,000 feet to Bayou De Glaise, along which it follows on the upper edge of cleared strip of land on its left bank for a distance of 57,600 feet, when it again leaves the bayou and runs across the swamp 10,200 feet to the Marksville Prairie, and has a total length of 23.2 miles.

The first route is shown by the estimates to have a slight advantage in point of economy.

Above Marksville Prairie there is another reach of river, the south bank of which is low, and over which high-water flows through Choctaw and other bayous to Lake Pearl, and from thence floods the country along Bayous Rouge and De Glaise. The principal objection to this plan, besides its great cost, is that by forcing all the water through so small an outlet the high-water level would thereby be increased, back-water raised above levees on Red and Ouachita rivers heretofore sufficient, and sections of country, previously above high-water, overflowed.

LOW-WATER OUTLET.

The second plan contemplates turning all the water of Red River out at this point only during stages below ordinary bank-height, and by means of an apron or tumbling dam allowing the surplus during flood stages to escape through the present channel. This seems, at first glance, both the simplest and most economical solution of the problem, as is does away with many miles of high levee, and would not greatly alter the present condition of affairs at times of high-water. The great objection to it is that the treacherous and unstable nature of the bed and banks offers great, if not an insurmountable, obstacle to the placing of such a dam in Red River with a promise of its having any degree of permanency. As stated before, the banks move in slides, reaching back several hundred feet from the water's edge, and I was unable to find any point at which such movement was not liable to take place. Thedam estimated for is an ordinary brush and earth structure, thoroughly riprapped on crown and slopes with 2 feet of loose stone. The foot of the slopes of dam on each side and both banks of river for 900 feet above and below dam, and bottom of river for 900 feet below dam, thoroughly protected with willow mattress work covered with 1 foot of loose stone. The estimate also includes the permanent closing of Lake Long to prevent the formation of a low-water channel through its course.

LOCATION OF CANAL.

Considered as a possible route for the proposed canal, the two lines run between the rivers south of the Cut-off (marked on the map line No. 1 and line No. 2, respectively) have each certain features which would make either desirable. The character of the material through which the cut would have to be made would be the same on both lines, being blue clay covered with a layer of sand varying from 10 to 20 feet in thickness.

Line No. 1 starts from Red River 1,000 feet below the mouth of Bayou Cocodrie and runs to a point just above Black Hawk Landing. It has a length of 18,400 feet, 4,100 feet of which runs through cultivated portions of Black Hawk plantation, the remainder being through low land densely covered with undergrowth and light timber of the following kinds: willow, bitter pecan, honey-locust, cottonwood, and cypress.

The principal advantage of this line as a location for the canal is its direction, which corresponds very nearly with the course of Red River above Bayou Cocodrie. It also enters the Mississippi in a non-caving bank and below the sand-bar, but as this bar appears to be slowly moving down, dredging might in time be necessary to keep an open channel at this point.

The amount of excavation required to construct a canal along this line, 100 feet wide on the bottom, 5 feet below low-water in Red River, and with 1 to 1 slopes, is 4,203,357 cubic yards, and a levee along its south bank reaching 3 feet above high-water would contain 610,896 cubic yards.

Line No. 2 starts from a point one-half mile below Black Hawk Landing and runs to Red River in a direction nearly at right angles to both streams. Its length is 17,900 feet, 3,300 feet of which is through cleared land, the remainder being through low timbered land of the same character as on line No. 1. Compared with line No. 1 it is found to be 500 feet shorter, to occupy much lower ground, and to enter the Mississippi in a caving bank at a safe distance below the sand-bar. Its direction, however, is its most objectionable feature, as it would necessitate an abrupt change in the course of Red River at its junction with that stream.

The amount of work required to construct a canal and levee along this line similar to those along line No. 1, is excavation 3,618,770 cubic yards, embankment 900,478 cubic yards.

A better idea of the relative values of these lines, considered as a location for the canal, can be obtained by an examination of their directions and elevations as shown on the maps and profiles herewith submitted.

LOCATION OF DAM IN RED RIVER.

Five sections (marked on the map section 1, 2, 3, 4, and 5) were sounded in Red River at points judged to be the most desirable locations for a dam. By calculation the amount of fill required to build a dam reaching to the top of the bank at each section was found to be as follows:

	Cubic yards.
Section No. 1	314,484
Section No. 2	322,305
Section No. 3	235,108
Section No. 4	224,412
Section No. 5	195,736

The banks at each of these sections is the same as far as apparent stability is concerned, thus making the amount of fill required the only consideration in the choice of a site for a dam. For this reason section No 5. will be used as the location for the dam in the estimate for an outlet along line No. 1, and section No. 3 in estimate for an outlet along line No. 2.

The following estimates give the cost of constructing a high-water outlet along both line No. 1 and line No. 2, and also of building levees by each route to Marksville Prairie. Estimates for constructing low-water outlets are also given for both lines.

The price per cubic yard of excavation is held to cover all cost of clearing and grubbing, and of placing material in levee on bank of cut, and in dam in Red River.

ESTIMATE OF QUANTITIES.

	Cubic yards.
Canal along line No. 1, 100 feet wide on the bottom, 5 feet below low-water in Red River and 1 to 1 slopes	4,203,359
Similar canal along line No. 2	3,618,770
Levee from dam in Red River up right bank to Marksville Prairie	2,896,320
Levee from dam in Red River to Marksville Prairie via Bayou De Glaise	3,052,411
Dam closing Lake Long	80,436

HIGH-WATER OUTLET ALONG LINE NO. 1, WITH LEVEE UP RIGHT BANK OF RED RIVER TO MARKSVILLE PRAIRIE.

Estimate.

4,203,359 cubic yards excavation, at 15 cents	$630,503 85
2,896,320 cubic yards embankment, at 20 cents	579,264 00
Superintendence and contingencies	8,000 00
Total	1,217,767 85

HIGH-WATER OUTLET ALONG LINE NO. 1, WITH LEVEE BY WAY OF BAYOU DE GLAISE TO MARKSVILLE PRAIRIE.

Estimate.

4,203,359 cubic yards excavation, at 15 cents	$630,503 85
3,052,411 cubic yards embankment, at 20 cents	610,482 20
Superintendence and contingencies	8,000 00
Total	1,248,986 05

HIGH-WATER OUTLET ALONG LINE NO. 2, WITH LEVEE UP RIGHT BANK OF RED RIVER TO MARKSVILLE PRAIRIE.

Estimate.

3,618,770 cubic yards excavation, at 15 cents	$542,815 50
2,896,320 cubic yards embankment, at 20 cents	579,264 00
Superintendence and contingencies	8,000 00
Total	1,130,079 50

HIGH-WATER OUTLET ALONG LINE NO. 2, WITH LEVEE BY WAY OF BAYOU DE GLAISE TO MARKSVILLE PRAIRIE.

Estimate.

3,618,770 cubic yards excavation, at 15 cents	$542,815 50
3,052,411 cubic yards embankment, at 20 cents	610,482 20
Superintendence and contingencies	8,000 00
Total	1,161,297 70

LOW-WATER OUTLET ALONG LINE NO. 1.

Estimate.

4,203,359 cubic yards excavation, at 15 cents	$630,503 85
80,436 cubic yards embankment in Lake Long, at 20 cents	16,087 20
48,815 cubic yards loose stone, at $2.75	134,241 25
125,111 square yards mattress protection, at $1	125,111 00
Superintendence and contingencies	6,000 00
Total	911,943 30

LOW-WATER OUTLET ALONG LINE NO. 2.

Estimate.

3,618,770 cubic yards excavation, at 15 cents	$542,815 50
80,436 cubic yards embankment in Lake Long, at 20 cents	16,087 20
48,818 cubic yards loose stone, at $2.75	134,241 25
125,111 square yards mattress protection, at $1	125,111 00
Superintendence and contingencies	6,000 00
Total	824,254 95

The maps submitted with this report consist of six sheets, showing the plan of all the territory embraced in the survey, made to a scale of 1 inch to 800 feet, and profiles of lines Nos. 1 and 2, of south bank of Grand Cut-off Bayou, of line from Marcotte Landing to Bayou De Glaise, and of five cross-sections of Red River below mouth of Bayou Cocodrie.

I finished the field-work October 4, and moved my party on board steamboat T. B. Florence, at mouth of Red River. According to your written instructions I then repaired water-gauges at Barbre's and Red River landings, and on October 11 turned the field party and instruments over to Mr. H. St. L. Coppée, who had been ordered to make certain observations at the mouth of Red River.

Before closing this report I desire to mention the intelligent and willing assistance rendered by Mr. William Shelton and Mr. J. Jay Smith during the progress of the survey, and the valuable aid of Mr. H. S. Jacoby and Mr. W. M. Rees in the preparation of the maps.

Very respectfully, your obedient servant,

F. S. BURROWES,
Assistant Engineer.

Maj. W. H. H. BENYAURD,
Corps of Engineers, U. S. A.

TABLE No. 1.

August, 1881.				September, 1881.			
Date.	Alexandria gauge.	Bayou Cocodrie gauge.	Difference in readings.	Date.	Alexandria gauge.	Bayou Cocodrie gauge.	Difference in readings.
1	—1.30	17.00	18.30	1	—3.10	1.90	5.00
2	—1.45	16.90	18.35	2	—3.10	1.90	5.00
3	—1.60	16.90	18.50	3	—3.10	1.70	4.80
4	—1.70	16.80	18.50	4	—3.10	1.50	4.60
5	—1.80	16.50	18.30	5	—3.15	1.40	4.55
6	—1.90	16.00	17.90	6	—3.20	1.20	4.40
7	—1.95	15.50	17.45	7	—3.20	1.00	4.20
8	—2.00	14.90	16.90	8	—3.25	0.90	4.15
9	—2.05	14.20	16.25	9	—3.30	0.80	4.10
10	—2.15	13.30	15.45	10	—3.35	0.60	3.95
11	—2.25	12.50	14.75	11	—3.40	0.50	3.90
12	—2.30	11.90	14.20	12	—3.45	0.30	3.75
13	—2.35	11.00	13.35	13	—3.50	0.20	3.70
14	—2.40	10.20	12.60	14	—3.50	0.00	3.50
15	—2.50	9.60	12.10	15	—3.50	0.40	3.90
16	—2.50	8.90	11.40	16	—3.50	0.40	3.90
17	—2.55	8.30	10.85	17	—3.45	0.40	3.85
18	—2.60	7.70	10.30	18	—3.50	0.30	3.80
19	—2.60	7.10	9.70	19	—3.50	0.30	3.80
20	—2.70	6.60	9.30	20	—3.50	0.20	3.70
21	—2.75	6.00	8.75	21	—3.50	0.20	3.70
22	—2.80	5.50	8.30	22	—3.50	0.30	3.80
23	—2.85	4.90	7.75	23	—3.55	0.20	3.75
24	—2.90	4.40	7.30	24	—3.55	0.20	3.75
25	—2.95	4.00	6.95	25	—3.60	0.20	3.80
26	—2.95	3.50	6.45	26	—3.60	0.20	3.80
27	—2.95	3.20	6.15	27	—3.65	0.50	4.15
28	—2.95	2.90	5.85	28	—3.65	0.70	4.35
29	—3.00	2.60	5.60	29	—3.70	0.90	4.60
30	—3.00	2.30	5.30	30	—3.60	1.00	4.60
31	—3.05	2.10	5.15				

Gauges in this table not connected by levels.

TABLE No. 2.

August, 1881.				September, 1881.			
Date.	Bayou Cocodrie gauge.	Barbre's Landing gauge.*	Difference in level.	Date.	Bayou Cocodrie gauge	Barbre's Landing gauge.*	Difference in level.
1	17.00	16.70	0.3	1	1.90	1.40	0.50
2	16.90	16.60	0.3	2	1.90	1.30	0.60
3	16.90	16.60	0.3	3	1.70	1.20	0.50
4	16.80	16.50	0.3	4	1.50	1.00	0.50
5	16.50	16.30	0.2	5	1.40	0.80	0.60
6	16.00	15.70	0.3	6	1.20	0.60	0.60
7	15.50	15.30	0.2	7	1.00	0.40	0 60
8	14.90	14.70	0.2	8	0.90	0.20	0.70
9	14.20	14.00	0.2	9	0.80	0.00	0.80
10	13.30	13.10	0.2	10	0.60	—0.20	0.80
11	12.50	12.30	0.2	11	0.50	—0.40	0.90
12	11.90	11.70	0.2	12	0.30	—0.60	0.90
13	11.00	10.80	0.2	13	0.20	—0.80	1.00
14	10.20	10.00	0.2	14	0.00	—0.80	0.80
15	9.60	9.40	0 2	15	0.40	—0.80	1.20
16	8.90	8.70	0.2	16	0.40	—0 80	1 20
17	8.30	8.10	0.2	17	0.40	—0.90	1.30
18	7.70	7.50	0.2	18	0.30	—1.00	1.30

TABLE No. 2—Continued.

August, 1881.				September, 1881.			
Date.	Bayou Cocodrie gauge.	Barbre's Landing gauge.*	Difference in level.	Date.	Bayou Cocodrie gauge.	Barbre's Landing gauge.*	Difference in level.
19	7.10	6.90	0.2	19	0.30	—0.90	1.20
20	6.60	6.30	0.3	20	0.20	—0.80	1.00
21	6.00	5.60	0.4	21	0.20	—0.70	0.90
22	5.50	4.90	0.6	22	0.30	—0.60	0.90
23	4.90	4.30	0.6	23	0.20	—0.60	0.80
24	4.40	3.80	0.6	24	0.20	—0.60	0.80
25	4.00	3.30	0.7	25	0.20	—0.60	0.80
26	3.50	2.90	0.6	26	0.20	—0.30	0.50
27	3.20	2.50	0.7	27	0.50	—0.05	0.55
28	2.90	2.10	0.8	28	0.70	0.20	0.50
29	2.60	1.80	0.8	29	0.90	0.45	0.45
30	2.30	1.60	0.7	30	1.00	0.70	0.30
31	2.10	1.50	0.6				

*Zero of both gauges in this table reduced to same level; that is, low-water of 1881 at mouth of Bayou Cocodrie.

TABLE No. 3.

August, 1881.				September, 1881.			
Date.	Black Hawk Landing gauge.	Bayou Cocodrie gauge.*	Difference in level.	Date.	Black Hawk Landing gauge.*	Bayou Cocodrie gauge.	Difference in level.
1	21.20	17.00	4.20	1	9.00	1 90	7.10
2	21.20	16.90	4.30	2	8.90	1.90	7.00
3	21.10	16.90	4.20	3	8.70	1.70	7.00
4	20.90	16.80	4.10	4	8.60	1.50	7.10
5	20.50	16.50	4.00	5	8.40	1.40	7.00
6	20.00	16.00	4.00	6	8.10	1.20	6.90
7	19.50	15.50	4.00	7	7.90	1.00	6.90
8	18.90	14.90	4.00	8	7.70	0.90	6.80
9	18.10	14.20	3.90	9	7.50	0.80	6.70
10	17.50	13.30	4.20	10	7.30	0.60	6.70
11	16.90	12.50	4.40	11	7.10	0.50	6.60
12	16.30	11.90	4.40	12	6.90	0.30	6.60
13	15.80	11.00	4.80	13	6.80	0.20	6.60
14	15.60	10.20	5.40	14	6.70	0.00	6.70
15	15.00	9.60	5.40	15	6.80	0.40	6.40
16	14.80	8.90	5.90	16	6.90	0.40	6.50
17	14.60	8.30	6.30	17	6.80	0.40	6.40
18	14.20	7.70	6.50	18	6.70	0.30	6.40
19	13.70	7.10	6.60	19	6.60	0.30	6.30
20	13.20	6.60	6.60	20	6.60	0.20	6.40
21	12.60	6.00	6.60	21	6.60	0.20	6.40
22	12.20	5.50	6.70	22	6.60	0.80	6.30
23	11.60	4.90	6.70	23	6.70	0.20	6.50
24	11.10	4.40	6.70	24	6.90	0.20	6.70
25	10.60	4.00	6.60	25	7.20	0.20	7.00
26	10.20	3.50	6.70	26	7.60	0.20	7.40
27	10.00	3.20	6.80	27	8.00	0.50	7.50
28	9.80	2.90	6.90	28	8.30	0.70	7.60
29	9.60	2.60	7.00	29	8.50	0.90	7.60
30	9.40	2.30	7.10	30	8.80	1.00	7.80
31	9.20	2.10	7.10				

*Zero of both gauges in this table reduced to same level; that is, low-water of 1881 at mouth of Bayou Cocodrie.

MOUTH OF RED RIVER.

REPORT OF MR. H. ST. L. COPPÉE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn.

MAJOR: In accordance with your instructions received October 8, 1881, I proceeded, accompanied by Mr. H. C. Wilson and Mr. Walter S. Davis, United States assistant engineer, to the mouth of Red River, Louisiana, to "take charge of the observations directed by a Board of Engineers on the improvement of the mouth of Red River." We finished the work as directed and returned to this office early in November. I have the honor to present herewith the following report on the above observations, with accompanying plates, sections, and tables.

REPORT.

I have endeavored to divide and arrange this report and annexed tables in such a manner as to facilitate an examination and comparison of the results with those obtained and tabulated by Mr. Rees the year previous.

On my arrival at the mouth of Red River October 11, 1881, Mr. Burrowes, who had just finished an extensive survey of the Bayou Cut-off route and the adjacent country, turned over to me his field party as per your order.

I found the gauges at Barbre's Landing (at the head of the Atchafalaya) and Red River Landing to be in good repair and correctly graduated.

The zero of the Atchafalaya, or Barbre's Landing, gauge is 0.325 of a foot above that of the Red River Landing gauge. The zero of Red River Landing gauge equals low-water of 1872. I took, as did Mr. Rees, the year previous, the zero of the former as a datum to which all my levels, water surfaces, soundings, &c., are referred.

The season for accomplishing the work was most auspicious. The mud-bars having been exposed to the sun during a long dry season of low-water, they had become hard; in no place did we find trouble in getting an accurate line of levels.

Our first operations were on the Atchafalaya River, commencing at Section II, a new section which we endeavored to locate between the same points as selected by Mr. Emile Steger in December, 1878. Thence we sounded the sections as located by Mr. Rees, 11 in number, the last being situated 3.32 miles below Barbre's Landing. Rees's stakes were found, and the operation of sounding, locating, &c., performed by Mr. H. C. Wilson and party in the same manner as the previous year. No continuous line of levels was run, but the height and change in bank determined by taking the water-level of the day, and reducing as per slope obtained from Rees's report.

In the same manner the sections in Old River, above and below the head of the Atchafalaya, were determined.

They are as follows: above, A, B, C, D, and 1, D and 1 being on either side of the head of the Atchafalaya; below, or through the crossing and Gut, E, F, G, H, I, Z, X, J, K, L, M, N, O, P, R, S, and T.

From foot of Turnbull's Island to Mississippi River, V, U, and W, U and W being on the outer bar.

Besides these sections, which were leveled when possible up to high-water mark or to top of bank, we sounded nine intermediate ones in Old River to compare with Rees's as follows: H′,I ,L′, M′,O′, R′, S′,T′, and V′. These latter will simply show the change in the channel below the water-line of the day on which the soundings were taken.

There being no appreciable slope between section A and Barbre's Landing all those intervening soundings were referred directly to the reading as taken on the gauge.

The elevation of the water at each section between the gauge (Section 1) and the Mississippi River (Section W) on the day and hour of sounding was referred to the zero of the gauge, as shown in the slope table (No. 3).

By means of a line of levels run by direction of Mr. Rees last year, I find the difference in elevation or slope of the Mississippi River between Section W and Red River Landings to be 0.30 feet; therefore, as per note in table, the zero of the Atchafalaya gauge being 0.30 feet above the zero of the Red River Landing gauge, and the Mississippi slope, as above, being also 0.30 feet, the water surface at present mouth of Red (Section W), referred to Atchafalaya gauge, equals same as reading on Red River Landing gauge. During the entire time of our observations the water was passing from the Mississippi River with a strong current through Lower Old River into the Atchafalaya, also through upper Old River and Sugar House Chute into the Red, and thence to the Atchafalaya.

Current and discharge observations were made October 25 in the same manner as the year previous and at the following points: Section A, Old River; section 5, Atchafalaya; and Section V, just below foot of Turnbull Island, with the results as shown in table (No. 4).

After completing all the work in the Achafalaya and Old River necessary for a comparison with the results of 1880, I resounded Rees's Angola Bar sections in the Mississippi as directed, and reran his shore-line on the west side from Carr's Point, noting the changes caused by the wear of the water on that bank, as shown in Map No. 1. A transit-line was also run between Section W and Red River Landing and three sections sounded across the river. (See Map No. 1.)

October the 24th I received a communication from you directing me before returning to Memphis to proceed with party to the neighborhood of Simmsport for the purpose of sounding a section of the Atchafalaya, in the vicinity of that place, and below the mouth of Bayou de Glaise, with reference to obtaining the best location for a dam, similar or to answer the same purpose as the one proposed by Mr. Hebert in his plan for the improvement of the mouth of the Red River in 1858. Before locating any section, I sounded in the channel down the Atchafalaya from the De Glaise to about a half mile below Simmsport, and found the depth increasing as far as we went, as follows (soundings referred to water-surface October 27, 1881): Just below mouth of De Glaise, 40 feet; opposite warehouse, 49 feet; opposite Ferry Landing, 54 feet, and about a half mile down, 60 feet. Many more soundings were taken, but these will suffice to show how much deeper the river becomes as you go downstream from the De Glaise. The two sections I selected, as shown by Map 2, are immediately above an abrupt bend in the river, one at the upper and the other at the lower end of the town of Simmsport. The river bottom at these sections is hard clay and sand. The levees in the vicinity on both sides of the river are intact. The high-water mark of 1874, which was preserved by a nail driven in a tree just above the town, is represented on profiles on Map No. 2. Transverse clay ridges are found in the river below Simmsport, causing the water to shoal considerably, but without sufficient base on which to erect a dam.

The position of Section A is probably the best site in this immediate vicinity for a high-water dam.

COMPARISON OF RESULTS OBTAINED IN 1880 AND 1881.

From the accompanying profiles, which were made from the notes obtained in the field, an estimate of the change which has taken place during the past year can readily be made. Table No. 2 gives such an estimate in condensed form, leaving but little to be explained.

ATCHAFALAYA.

The change in the Atchafalaya since October, 1880, as seen by the table (2), is in every instance, with the exception of Section 2 at the head, a scour both above and below, 8 feet on the gauge; this scour varies from 263 to 2,586 square feet, the average being about 1,100 square feet on each section through that portion of the river sounded. The high-water width has changed very little, most of the scour having taken place below 30 feet on the gauge. The excess of fill on Section 2, as shown by the compared profiles of 1880 and 1881, is confined to the deepest portion of the section, which is not the channel propper, but a hole formed by an eddy caused by the confluence of the water from the Red and Mississippi at that point; the channel and banks show a decided cut.

Otherwise, as above stated, the Atchafalaya River, from its head to the last section sounded, 3.2 miles below, has, from October, 1880, to October, 1881, scoured its channel and banks on an average of 1,100 square feet per section, each section being from 37,000 to 47,000 square feet in area.

OLD RIVER.

In Old River, Section A at high-water shows a fill of 1,565 square feet. Section B also fills 1,994 square feet. Section C cuts out a very little (304 square feet), and Section D shows a decided fill again of 1,083 square feet; thence from Section 1, at head of Atchafalaya, with but three exceptions, there is a continuous scour in the crossing through the Gut, and to the Mississippi River at W.

The exceptions to this scour are at Sections E, G, and U. Low-water area at E shows a fill of 510 square feet, high-water area at G shows a fill of 12 square feet, and low-water area at U a fill of 1,516 square feet.

By a careful examination of the compared profiles of Old River (the crossing, Gut, &c.), I find the changes in depth of the channel as follows: Section A shows a slight cut: Section B a slight fill; Section C cuts 1½ feet; Section D a fill of 2 feet; Sections 1 to V scour as follows:

Section 1, 13 feet scour in channel.
Section E, 1 foot scour in channel.
Section F, 6 feet scour in channel.

Section G, 7 feet scour in channel.
Section H, 10 feet scour in channel.
Section I, 10 feet scour in channel.
Section Z, 4 to 12 feet scour in channel.
Section X, 5 feet scour in channel.
Section J, 4 feet scour in channel.
Section K, 8 feet scour in channel.
Section L, 4 feet scour in channel.
Section M, 0.2 foot scour in channel.
Section N, 5 feet scour in channel.
Section O, 10 feet scour in channel.
Section P, 8 feet scour in channel.
Section R, 7 feet scour in channel.
Section S, 11 feet scour in channel.
Section T, 11 feet scour in channel.
Section V, 5 feet scour in channel.
Section U, in left channel, scour 13 feet; in right channel, fill 25 feet.
Section W, in left channel, scour 11 feet; in right channel, no change.

From these figures it will be seen that the general tendency of the current, through the entire reach sounded in Old River, was to scour. From the head of the Atchafalaya to Section U the cut in the channel is from 4 to 11 feet. Sections U and W, on the outer bar, have undergone the heaviest changes. At U the channel has divided, and at W the current cut the bar 11 feet below its elevation last year.

On the mud-bars the change has been very slight from A to D, there being a fill; 1 and E show cut and fill equal; F, G, H, I, a fill; Z and X, no change; J, a slight cut; K, a fill; thence no change to mouth. The exact amount of these differences on the bars it is hard to estimate, because of the necessarily exaggerated scale to which the profiles are made.

A recapitulation of the above will show that between the time of Mr. Rees's observations and those made last October, the Atchafalaya River, from its head to 3.2 miles below, has scoured its bed below high-water, the Old River above the head of the Atchafalaya both filled and scoured, and from that point to the outer bar scoured its channel without exception. Also that the deposit or fill on the mud-bars during high-water was slight and not uniform throughout.

I have appended a table of the gauge readings recorded at Barbre's Landing and Red River Landing, from February 1 to November 1, 1881, showing the difference in the readings and the direction of the current through Lower Old River; also a hydrograph of these gauges during that time. By a glance at the hydrograph it will be seen that during the nine months from February 1 to November 1, 1881, there were but three months (March, April, and May) when the water was practically at a stand-still; this was during high-water, and probably the time when the deposit on the bars took place. Since then and up to the present date there has been a current through Lower Old River at times so swift that steamboats had great trouble in stemming it. To this continuous current, particularly at low-water, as shown by difference on gauges during August, September, and October, is due, I think, the great scour throughout the low-water channel. The current in the crossing was concentrated and made much more effective by brush jetties built during the summer under the superintendence of Captain Lydon.

The accompanying map (No. 3) is taken from Mr. Rees' map of the survey made last year. It shows the position of the sections sounded in plan and some of the comparisons, both in the Atchafalaya and Lower Old River, in profile.

Before closing this report I wish to state that I had Mr. Wilson's valuable assistance both in the field, in charge of the instrumental work, and in the office. I also wish to acknowledge Captain Lydon's attention. He rendered us every assistance in his power in the way of labor, transportation, &c., to further the operations.

Very respectfully, your obedient servant,

H. St. L. Coppée,
Assistant Engineer.

Maj. W. H. H. Benyaurd,
Corps of Engineers, U. S. A.

TABLE 1.—*Gauge readings at Red River Landing and Barbre's Landing, Louisiana, from February* 1 *to November* 1, 1881; *their difference and the direction of the current through Old River.*

Date.		Red River Landing.	Barbre's Landing.	Difference.	Direction of current.	Remarks.
				Ft.		
Feb.	1	27.85	27.30	0.05	In.	
	2	28.05	28.20	0.15	Out.	
	3	29.60	29.00	0.60	In.	
	4	30.40	29.70	0.70	In.	
	5	30.80	30.30	0.50	In.	
	6	31.30	31.10	0.20	In.	
	7	32.30	32.00	0.30	In.	
	8	32.40	32.10	0.30	In.	
	9	32.50	32.30	0.20	In.	
	10	32.50	32.40	0.10	In.	
	11	32.50	32.40	0.10	In.	
	12	32.40	32.40	0.00	No current.	
	13	32.10	31.90	0.20	In.	
	14	31.80	31.70	0.10	In.	
	15	31.40	31.40	0.00	No current.	
	16	31.40	31.50	1.10	No current.	
	17	31.80	31.70	0.10	In.	
	18	32.60	32.40	0.20	In.	
	19	33.50	33.20	0.30	In.	
	20	34.60	34.20	0.40	In.	
	21	35.40	35.10	0.30	In.	
	22	36.20	35.60	0.60	In.	
	23	36.90	36.10	0.80	In.	
	24	37.30	36.50	0.80	In.	
	25	37.60	36.80	0.80	In.	
	26	37.90	37.10	0.80	In.	
	27	38.30	37.40	0.90	In.	
	28	38.40	37.60	0.80	In.	
Mar.	1	38.50	37.70	0.80	In.	
	2	38.60	37.80	0.80	In.	
	3	38.70	37.90	0.80	In.	
	4	38.80	38.00	0.80	In.	
	5	38.90	38.10	0.80	In.	
	6	39.00	38.10	0.90	In.	
	7	39.00	38.20	0.80	In.	
	8	39.00	38.30	0.70	In.	
	9	39.05	38.40	0.65	In.	
	10	39.10	38.50	0.60	In.	
	11	39.15	38.60	0.55	In.	
	12	39.20	38.80	0.40	In.	
	13	39.20	38.80	0.40	In.	
	14	39.20	38.90	0.30	In.	
	15	39.25	38.90	0.35	In.	
	16	39.25	39.00	0.25	In.	
	17	39.25	39.00	0.25	In.	
	18	39.30	39.10	0.20	In.	
	19	39.40	39.40	0.00	No current.	
	20	39.45	39.40	0.05	No current.	
	21	39.35	39.40	0.05	No current.	
	22	39.30	39.30	0.00	No current.	
	23	39.25	39.30	0.05	No current.	
	24	39.25	39.30	0.05	No current.	
	25	39.25	39.30	0.05	No current.	
	26	39.35	39.30	0.05	No current.	
	27	39.40	39.40	0.00	No current.	
	28	39.50	39.50	0.00	No current.	
	29	39.60	39.60	0.00	No current.	
	30	39.70	39.70	0.00	No current.	
	31	30.80	39.80	0.00	No current.	
Apr.	1	39.85	39.90	0.05	No current.	
	2	39.90	39.90	0.00	No current.	
	3	39.95	39.90	0.05	No current.	
	4	40.00	40.00	0.00	No current.	
	5	40.05	40.00	0.05	No current.	
	6	40.10	40.00	0.10	In.	Very light current
	7	40.10	40.00	0.10	In.	
	8	40.10	40.00	0.10	In.	
	9	40.10	40.00	0.10	In.	
	10	40.05	39.90	0.15	In.	
	11	39.95	39.80	0.15	In.	
	12	39.85	39.70	0.15	In.	
Apr.	13	39.75	39.80	0.05	No current.	
	14	39.65	39.70	0.05	No current.	
	15	39.60	39.60	0.00	No current.	
	16	39.45	39.50	0.05	No current.	
	17	39.35	39.50	0.15	Out.	Very light current
	18	39.30	39.40	0.10	Out.	
	19	39.25	39.30	0.05	Out.	
	20	39.20	39.20	0.00	No current.	
	21	39.15	39.20	0.05	No current.	
	22	39.10	39.30	0.20	No current.	
	23	39.10	39.20	0.10	No current.	
	24	39.15	39.20	0.05	No current.	
	25	39.20	39.20	0.00	No current.	
	26	39.25	39.10	0.15	In.	
	27	39.20	39.10	0.10	In.	
	28	39.15	39.00	0.15	In.	
	29	39.10	38.90	0.20	In.	
	30	39.05	38.90.	0.15	In.	
May	1	39.00	38.80	0.20	In.	
	2	39.00	38.80	0.20	In.	
	3	39.00	38.70	0.30	In.	
	4	39.00	38.70	0.30	In.	
	5	38.95	38.60	0.35	In.	
	6	38.90	38.60	0.30	In.	
	7	38.90	38.60	0.30	In.	
	8	39.10	38.80	0.30	In.	
	9	39.20	38.90	0.30	In.	
	10	39.25	38.90	0.35	In.	
	11	39.30	38.90	0.40	In.	
	12	39.30	38.90	0.40	In.	
	13	39.25	38.90	0.35	In.	
	14	39.20	38.90	0.30	In.	
	15	39.10	38.90	0.20	In.	
	16	39.05	38.80	0.25	In.	
	17	39.00	38.70	0.20	In.	
	18	39.00	38.80	0.30	In.	
	19	39.00	38.70	0.30	In.	
	20	39.05	38.70	0.35	In.	
	21	39.10	38.80	0.30	In.	
	22	39.20	38.90	0.30	In.	
	23	39.25	39.00	0.25	In.	
	24	39.30	39.10	0.20	In.	
	25	39.35	39.20	0.15	In.	
	26	39.35	39.20	0.15	In.	
	27	39.40	39.30	0.10	In.	
	28	39.45	39.30	0.15	In.	
	29	39.45	39.40	0.05	No current.	
	30	39.50	39.50	0.00	No current.	
	31	39.55	39.50	0.05	No current.	
June	1	39.60	39.60	0.00	No current.	
	2	39.60	39.70	0.10	No current.	
	3	39.60	39.70	0.10	No current.	
	4	39.65	39.70	0.05	No current.	
	5	39.60	39.70	0.10	Out.	
	6	39.45	39.70	0.25	Out.	
	7	39.25	39.70	0.45	Out.	
	8	38.95	39.60	0.65	Out.	
	9	38.55	39.50	0.95	Out.	
	10	38.25	39.20	1.05	Out.	
	11	37.85	38.90	1.05	Out.	
	12	37.25	38.60	1.35	Out.	
	13	36.65	38.10	1.45	Out.	
	14	36.05	37.70	1.65	Out.	
	15	35.45	37.40	1.95	Out.	
	16	34.85	36.70	1.85	Out.	
	17	34.25	36.20	1.95	Out.	
	18	33.70	35.60	1.90	Out.	
	19	33.00	35.10	2.10	Out.	
	20	32.50	34.60	2.10	Out.	
	21	32 00	34.00	2.00	Out.	
	22	31.80	33.70	1.90	Out.	

Gauge readings at Red River Landing, &c.—Continued.

Date.	Red River Landing.	Barbre's Landing.	Difference.	Direction of current.	Remarks.
			Ft.		
June 23	31.60	33.20	1.60	Out.	
24	31.60	33.00	1.40	Out.	
25	31.70	32.70	1.00	Out.	
26	31.85	32.70	0.85	Out.	
27	32.15	32.70	0.55	Out.	
28	32.40	32.80	0.40	Out.	
29	32.65	32.90	0.25	Out.	
30	32.80	32.90	0.10	Out.	
July 1	32.90	32.90	0.00	No current.	
2	32.90	32.90	0.00	No current.	
3	32.80	23.80	0.00	No current.	
4	32.50	32.60	0.10	Out.	
5	32.10	32.20	0.10	Out.	
6	31.60	31.80	0.20	Out.	
7	31.10	31.40	0.30	Out.	
8	30.50	30.80	0.30	Out.	
9	29.90	30.30	0.40	Out.	
10	29.50	29.70	0.20	Out.	
11	28.90	29.10	0.20	Out.	
12	28.40	28.50	0.10	Out.	
13	27.90	28.00	0.10	Out.	About on a stand.
14	27.45	27.50	0.05	Out.	
15	26.95	27.10	0.15	Out.	
16	26.55	27.00	0.45	Out.	
17	25.85	26.00	0.15	Out.	
18	25.05	25.10	0.05	Out.	
19	24.25	24.10	0.15	In.	
20	23.45	23.10	0.35	In.	
21	22.35	22.00	0.55	In.	
22	21.55	20.90	0.65	In.	
23	20.55	19.70	0.85	In.	
24	19.55	18.50	1.05	In.	
25	18.55	17.50	1.05	In.	
26	17.85	16.80	1.05	In.	
27	17.60	16.70	0.90	In.	
28	17.60	16.60	1.00	In.	
29	17.60	16.60	1.00	In.	
30	17.60	16.50	1.10	In.	
31	17.60	16.50	1.10	In.	
Aug. 1	17.50	16.50	1.00	In.	Current very swift.
2	17.30	16.40	0.90	In.	
3	17.00	16.40	0.60	In.	
4	16.80	16.30	0.50	In.	
5	16.50	16.10	0.40	In.	
6	16.30	15.50	0.80	In.	
7	15.90	15.10	0.80	In.	
8	15.40	14.50	0.90	In.	
9	14.80	13.80	1.00	In.	
10	14.10	12.90	1.20	In.	
11	13.50	12.10	1.40	In.	
12	13.00	11.50	1.50	In.	
13	12.50	10.60	1.90	In.	
14	12.00	9.80	2.20	In.	
15	11.65	9.20	2.45	In.	
16	11.35	8.50	2.85	In.	
17	11.15	7.90	3.25	In.	
18	10.85	7.30	3.55	In.	
19	10.35	6.70	3.65	In.	
20	9.80	6.10	3.70	In.	
21	9.15	5.40	3.75	In.	
22	8.55	4.70	3.85	In.	
23	8.05	4.10	3.95	In.	
24	7.65	3.60	4.05	In.	
25	7.25	3.10	4.15	In.	
26	7.00	2.70	4.30	In.	
27	6.70	2.30	4.40	In.	
28	6.55	1.90	4.65	In.	
29	6.30	1.60	4.70	In.	
30	1.10	1.40	4.70	In.	
31	5.90	1.30	4.60	In.	
Sept. 1	5.80	1.20	4.60	In.	
2	5.70	1.10	4.60	In.	
3	5.60	1.00	4.60	In.	
4	5.30	0.80	4.50	In.	
5	5.10	0.60	4.50	In.	
6	4.90	0.40	4.50	In.	
7	4.70	0.20	4.50	In.	
8	4.50	0.00	4.50	In.	
9	4.20	—0.20	4.40	In.	
10	4.00	—0.40	4.40	In.	The minus sign=below zero.
11	3.80	—0.60	4.40	In.	
12	3.70	—0.80	4.50	In.	
13	3.60	—1.00	4.60	In.	
14	3.50	—1.00	4.50	In.	
15	3.50	—1.00	4.50	In,	
16	3.70	—1.00	4.70	In.	
17	3.60	—1.10	4.70	In.	
18	3.55	—1.20	4.75	In.	
19	3.50	—1.10	4.60	In.	
20	3.45	—1.00	4.45	In.	
21	3.40	—0.90	4.30	In.	
22	3.40	—0.80	4.20	In.	
23	3.55	—0.80	4.35	In.	
24	3.70	—0.80	4.50	In.	
25	3.95	—0.80	4.75	In.	
26	4.45	—0.50	4.95	In.	
27	4.95	—0.25	5.20	In.	
28	5.20	0.00	5.20	In.	
29	5.45	0.25	5.20	In.	
30	5.70	0.50	5.20	In.	
Oct. 1	5.85	0.70	5.15	In.	Strong current in.
2	6.00	0.75	5.25	In.	
3	6.30	0.80	5.50	In.	
4	6.70	0.90	5.80	In.	
5	7.10	1.00	6.10	In.	
6	7.40	1.20	6.20	In.	
7	7.60	1.40	6.20	In.	
8	7.70	1.60	6.10	In.	
9	8.10	2.20	5.90	In.	
10	8.70	2.60	6.10	In.	
11	9.60	3.00	6.60	In.	
12	10.60	3.40	7.20	In.	
13	11.80	4.60	7.20	In.	
14	12.80	5.80	7.00	In.	
15	13.80	7.40	6.40	In.	
16	14.40	8.90	5.50	In.	
17	14.90	10.20	4.70	In.	Strong current.
18	15.20	11.30	3.90	In.	
19	15.50	12.20	3.30	In.	
20	15.75	12.80	2.95	In.	
21	15.95	13.40	2.55	In.	
22	16.15	13.80	2.35	In.	
23	16.35	14.10	2.25	In.	
24	16.45	14.60	1.85	In.	
25	16.55	14.90	1.65	In.	
26	16.55	15.00	1.55	In.	
27	16.55	15.10	1.45	In,	
28	17.95	16.20	1.75	In.	
29	18.45	18.00	0.45	In.	
30	18.95	18.70	0.25	In.	
31	19.25	18.90	0.35	In.	

TABLE 2.—*Showing changes in areas and widths of sections, sounded by W. M. Rees, October, 1880, and H. St. L. Coppée, October, 1881.*

Sections as shown on Map No. 3.	Areas at high-water and 30 feet on gauge.		Change during year.		Areas below 8 feet on the gauge.		Change during year.		High-water width.		30 feet width.		8 feet width.		Remarks.
	Rees, October 1880.	Coppée, Oct., 1881.	Scour.	Fill.	Rees, Oct., 1880.	Coppée, Oct., 1881.	Scour.	Fill.	Rees, 1880.	Coppée, 1881.	Rees, 1880.	Coppée, 1881.	Rees, 1880.	Coppée, 1881.	
	High-water.														
	Sq. feet.	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
Atchafalaya, 2	76,917	75,748	....	1,169	37,971	36,303	....	1,668	1,130	1,140	....	....	824	851	
Atchafalaya, 3	43,465	45,850	2,586	....	16,769	18,162	1,393	....	820	824	....	....	547	589	
Atchafalaya, 4	35,289	36,776	1,487	....	10,044	10,174	130	....	852	851	....	....	477	494	
Atchafalaya, 5	36,731	38,093	1,362	....	10,307	11,077	770	....	816	824	....	....	452	494	
Atchafalaya, 6	38,089	38,352	263	....	12,082	12,096	13	....	855	855	....	....	493	494	
Atchafalaya, 7	38,896	39,422	526	....	12,150	13,410	1,260	....	800	804	....	....	504	507	
Atchafalaya, 8	36,218	37,259	1,041	....	11,713	12,194	481	....	720	732	....	....	483	489	
Atchafalaya, 9	39,605	40,702	1,097	....	15,158	15,498	340	....	755	775	....	....	457	467	
Atchafalaya, 10	45,596	46,374	778	....	15,981	16,951	970	....	855	860	....	....	640	643	
Atchafalaya, 11	45,080	46,146	1,066	....	15,362	15,868	506	....	895	899	....	....	610	649	
Atchafalaya, 12	46,343	47,164	821	....	16,372	16,831	459	....	840	847	....	....	665	675	
Old River, A	98,190	96,625	....	1,565	24,222	23,300	....	922	2,120	2,132	....	....	1,320	1,308	High-water width of A is measured to the bar as shown on profile.
	30 feet on gauge.														
Old River, B	49,674	47,680	....	1,994	21,074	20,177	....	897	....	....	1,618	1,620	820	818	Section=B at Water-Valley Landing.
Old River, C	44,949	45,253	304	....	20,200	20,470	270	....	....	....	1,375	1,380	860	883	
Old River, D	43,089	42,006	....	1,083	20,404	19,205	....	1,199	....	....	1,150	1,162	860	856	Sections 1 and D at head of Atchafalaya in Old River.
Old River, 1	33,437	35,257	1,820	....	7,248	9,045	1,761	....	....	....	1,450	1,471	844	844	
	High-water.														
Old River, E	97,576	98,078	502	....	5,800	5,290	....	510	3,440	3,430	....	....	415	415	
Old River, F	88,470	88,690	220	....	3,434	4,806	1,372	....	2,800	2,800	....	....	485	505	
Old River, G	91,462	91,450	....	12	1,782	4,508	2,626	....	2,850	2,850	....	....	600	625	Section G at Chandler's Landing.
Old River, H	95,506	96,702	1,200	....	1,442	4,028	2,586	....	2,865	2,865	....	....	587	650	
Old River, I	83,928	86,650	2,722	....	1,516	3,890	2,374	....	2,660	2,660	....	....	625	660	
Old River, Z	86,266	89,258	2,992	....	4,664	7,778	3,110	....	2,360	2,360	....	....	1,610	1,620	Section Z = middle of crossing.
Old River, X	93,404	94,278	874	....	4,960	6,022	1,062	....	2,580	2,580	....	....	1,310	1,325	
Old River, J	110,364	115,590	5,226	....	6,764	9,258	2,494	....	3,070	3,070	....	....	1,560	1,750	
Old River, K	135,636	138,426	2,760	....	5,228	6,142	914	....	4,100	4,100	....	....	1,580	1,570	Section K — near Ash Cabin.

TABLE 2.—*Showing changes in areas and widths of sections, sounded by W. M. Rees, &c.*—Continued.

Sections as shown on Map No. 3.	Areas at high-water and 30 feet on gauge.		Change during year.		Areas below 8 feet on the gauge.		Change during year.		High-water width.		30 feet width.		8 feet width.		Remarks.
	Rees, October, 1880.	Coppée, Oct., 1881.	Scour.	Fill.	Rees, October, 1880.	Coppée, Oct., 1881.	Scour.	Fill.	Rees, 1880.	Coppée, 1881.	Rees, 1880.	Coppée, 1881.	Rees, 1880.	Coppée, 1881.	
	30 feet on gauge.														
	Sq. feet.	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
Old River, L	15,606	18,648	3,042	....	2,168	2,524	356	....	....	....	900	900	320	380	
Old River, M	15,316	16,832	1,516	....	2,180	2,634	454	....	....	....	830	830	305	840	
Old River, N	17,144	17,572	428	....	2,090	2,680	590	....	....	....	1,000	1,005	375	390	
Old River, O	16,538	17,644	1,106	....	1,936	2,896	960	....	....	....	930	940	375	365	
Old River, P	15,748	16,950	1,202	....	1,952	2,968	1,016	....	....	....	820	820	315	360	
Old River, R	15,206	15,992	786	....	1,702	2,502	800	....	....	....	775	775	840	375	
Old River, S	13,832	15,734	1,902	....	2,270	4,586	2,316	....	....	....	720	720	340	350	
Old River, T	15,282	19,262	3,980	....	3,724	7,618	3,894	....	....	....	605	600	390	465	Section T = foot of Turnbull Island.
Old River, V	18,134	19,512	1,378	....	3,870	5,614	1,744	....	....	....	780	760	530	545	
Old River, U	30,764	31,358	684	....	7,438	5,922	....	1,516	....	....	1,330	1,330	380	810	Sections U and W = outer bar.
Old River, W	32,746	35,242	2,496	....	3,380	6,100	2,720	....	....	....	1,595	1,640	1,023	1,025	
Old River, X	....	....	....	....	2,044	3,026	982	....	....	....	....	....	520	520	These areas and widths are in channel only, at 8 feet on the gauge.
Old River, J	....	....	....	....	2,470	4,456	1,988	....	....	....	....	....	370	640	
Old River, K	....	....	....	....	1,918	3,226	1,308	....	....	....	....	....	315	470	

TABLE 3.—*Showing difference in elevation to be added to gauge-reading at each section on day and hour of sounding.*

Date.	Section.	Approximate distance of section from the Atchafalaya gauge.	+ difference.	Date.	Section.	Approximate distance of section from the Atchafalaya gauge.	+ difference.
1881.	*Old River.*	*Feet.*	*Feet.*	1881.	*Old River.*	*Feet.*	*Feet.*
October 21.....	G	6,800	0.5	October 24....	O	21,600	1.1
21.....	H	8,400	0.6	24....	P	22,800	1.1
21.....	I	10,000	0.7	24....	R	24,000	1.2
21.....	Z	10,800	0.8	24....	S	26,000	1.3
21.....	X	11,200	0.8	24 ...	T	27,600	1.4
21.....	J	12,800	0.9	25....	V	31,200	1.4
21.....	K	16,000	1.1	24....	Y	34,000	1.6
22.....	L	17,600	1.1	24....	U	34,400	1.7
22.....	M	18,400	1.2	25....	W	35,200	1.6
22	N	20,000	1.2				

The slope was not uniform throughout this entire reach, but the difference was so slight as to make this table practically correct.

TABLE 4.—*Table of velocity and discharge, October 25, 1881.*

Date.	Discharge section.	Cubic feet per second.	Mean velocity, feet per second.
October 25, 1881	Red River above Sugar House chute.................	10,557	0.39
Do	Mississippi River, through Old River, at Section V...	18,924	1.82
Do	Atchafalaya at Section 5........................	29,481	2.02

P 5.

REMOVING RAFT IN RED RIVER, AND CLOSING TONE'S BAYOU.

RAFT.

Operations were continued on Red River above Shreveport with the steamer Florence, for the purpose of keeping the channel clear of obstructions.

In September, when the river was at a very low stage, a force was put to work between Shreveport and Shady Grove, and that entire stretch of river was so thoroughly cleared out that boats can now run on a stage of water 4 feet below what they formerly could.

During the high-water season the Florence was kept patrolling the river from Shreveport to the head of the raft, sometimes going as high as Fulton, Ark. Thirty-five jams or drift-piles were removed, and a clear channel maintained.

Considerable difficulty is experienced in keeping the river clear, from the fact that the lumber and saw-mill people allow their lumber rafts to block up the channel and so cause a vast accumulation of drift, that eventually proves a serious obstruction and difficult to remove. Their attention has been called to the fact, but thus far without avail. In previous reports I have brought the matter forward, but no action has ever been taken.

CLOSING TONE'S BAYOU.

A contract was entered into with A. L. Gervin and John A. Bietey for building an earthen dam across Tone's Bayou, and connecting with the levees on Red River. According to the terms of the contract the work was to be completed during the low-water season of 1881.

On July 9, 1881, Messrs. Gervin and Bietey were notified that their bid had been accepted, and they were requested to appear with their sureties for the purpose of entering into the contract.

In consequence of the absence of one of their bondsmen, the proper execution of the papers was delayed, and it was not until August 31 that I could notify them of the approval of the contract by the Chief of Engineers.

Active operations were commenced about the 3d or 4th of September, still leaving ample time to complete the work within the designated time, had it been pushed, but it went on so slowly that my assistant on the work informed the contractors that unless the work progressed more rapidly he would have to report that they had not complied with the terms of their contract. The specifications were explicit as to the amount of earth that would be required in the embankment during the first 14 days, namely, 25,000 cubic yards. The work, however, went along so slowly that after about a month's work but 12,000 cubic yards had been taken from the pits, less than half the amount that should have been moved during the first two weeks.

This was about the period of the very lowest water, and therefore the greatest amount of work should have been done. The contractors knew that the season of low-water could not reasonably be expected to continue longer than two months, and that they had lost about three weeks of that season before they commenced work.

As it was, but little energy appeared in the conduct of the work until the water began to rise. Even then if the work had been pushed, as it could well have been, the whole would have been completed in season, and before the rising water so seriously interfered with their operations. About the first week in October the water commenced to rise, and continued until the 26th of November, when it began to recede, and fell a little less than 1 foot in all. All this time the contractors had all they could do with the force employed to keep the main dam above the water line, with sufficient width of base to offer a sufficient resistance to the pressure of the water on the river side of the work. At one time the difference of water levels on the two sides of the dam was 15.2 feet.

On the 28th of November, after the river had fallen, it was 14.3.

The work was measured by Mr. Melvin, assistant engineer, and Mr. Crane, a civil engineer of Shreveport, on the 28th of November, and it was found that the dam at Lower Old River still needed some 6,000 yards to complete it, and on the main dam there was still required about 12,000 yards.

On the morning of the 1st of December, I was informed by telegraph that the Confederate Dam had been destroyed, and that the contractor's work in Lower Old River was swept out. I immediately took steps to ascertain the full circumstances connected with the matter, and am of the opinion that the dam had been maliciously destroyed. It had been reported to me that the dam was leaking, but after I had examined it I could find no cause for such a belief. This examination was made by me about a week or ten days before the structure gave way. Without being tampered with, this old dam would have stood all the pressure that any stage of water on Red River could bring against it. It had stood the test of nineteen years of high-water. Three of those years the water had run over the top to a depth of nearly 1 foot above the crown. The deposit on both sides had been large, and had greatly increased the strength of the original work. The deposit on the bayou side had reached to within a few feet of the top of the embankment itself and extended to the water channel of the bayou. On the rear or lower side of the embankment the deposit had been made out fully 300 feet from the original constructed bank. Through the center of this embankment cribs of timber had been built and the earth-work had been compactly built in and around them. The dam, as it stood when the work of this year was commenced, was capable of sustaining much more pressure than the water at the time could exert against it.

The contractors advanced the idea that when the disaster to the Confederate Dam occurred they were within a few hours of having the work completed.

The work was measured, as previously stated, and it was found that the small dam needed nearly 6,000 yards, and the main dam about twice that quantity. Between the time that Mr. Melvin measured it until the time the Confederate Dam gave way there could not have been more than fourteen hours' work performed, namely, four on the 29th and ten on Wednesday, the 30th. It is reported by the assistant that there were at work on the different sections twelve wheel-scrapers and teams, and from fifteen to eighteen drag-scrapers and teams, and a few laborers with shovels. This force, had it been kept at work, could not possibly have finished the work in ten or twelve days of good working time, but on the morning of the 30th everything at work the day before was discharged except the wheel-scrapers and the men and teams working them. These could not have put into the dumps more than 35 cubic yards each in one day, making the aggregate day's work for all 420 yards. How the work could have been finished in the time claimed by the contractors is not clearly seen from these figures.

The destruction of the Confederate Dam caused then the destruction of the small dam across Lower Old River, then in an unfinished condition. It is doubted even if this latter work had been fully completed that it could have withstood the sudden withdrawal of water from behind it, having been built in 20 feet of water and of fresh earth. It would have required probably upwards of a month to assume a consistency sufficiently firm to resist the pressure forced against it. It is, however, certain that if the contractor had pushed his work during the first thirty days of operations the work would have been done before the 15th of November, and the water in Old River would not have seriously interfered with the operations. But very little work was done afterwards on the remaining part of the lower main dam.

On the 4th of February following (1882), according to the affidavits of Felix Ouray, agent for the contractors, and several of his men, a body of masked men approached the main dam, took charge of the guards, and cut a ditch across the dam, the effect of which was to cause its entire destruction. The contractors applied to me for the payment of the entire amount of the contract price for the work, but as the same had never been completed nor accepted by me, I declined to pay any portion of the amount.

The drawings herewith will show the position of the different dams alluded to in the report.

There has always been considerable opposition by the planters and others in the vicinity of this work to the closing of the bayou. Those planters along the front or on Red River proper seem to think that the damming of the bayou would cause the overflow of their lands, while those living on the back channel, or Bayou Pierre, desire to have this latter cleaned out and otherwise improved and made the main steamboat channel from the head of Tone's Bayou to Grand Ecore. So far has this opposition made itself felt that I have taken the liberty of inserting here these two items taken from the Shreveport Times, the leading newspaper of that section of the country. The first is the editorial comments on a letter of Hon. N. C. Blanchard on the question of closing the bayou, and the other is a part of a communication from an old planter, Mr. Frierson, on the same subject:

> The question is one that can only be definitely settled by thoroughly competent engineers, and hence we shall not venture an opinion upon it. This much we can safely say, however: If the government should build a dam across Old River at the head of Tone's Bayou that would prove permanent against the forces of nature, so to speak, it would be under the necessity of keeping an armed force constantly on the ground, or it would be cut by parties whose lands would thereby be subject to overflow.
>
> Should Tone's Bayou be successfully closed, it would require a regiment to guard the work during high-water. The planters on east bank of Red River would cut it, in spite of—yes—well, say six regiments. Who would or could blame them? 'Tis folly to talk of indemnification. To let the matter stand as it is now, viz, severely alone, is absolute destruction, not only to low-water but to high-water navigation. Red River will be inevitably drained, and that in the near future. This fact has been patent to the apprehension of the most casual observer for years.

The question naturally arises, What shall be done for the best interests of navigation? Close Tone's Bayou and stop the loss of water from the main channel, or allow the bayou to remain open and clear out and remove all obstructions from Bayou Pierre and Lakes Bayou Pierre and Cannosanier and Bayou Winsey, and make that route the navigable channel. This latter is, I believe, in contemplation. The new river and harbor bill contains all the appropriations for Red River under one general title, "the improvement of Red River," and it would be advisable to consider the matter before any steps be taken to carry out the scheme.

I have had an examination of the above route made, and have reported in favor of keeping the main channel of Red River as it now is and close Tone's Bayou. Major Howell had also reported upon the same subject.

Taking the map herewith, it will be seen that Red River leaves the high land where Bayou Pierre leaves the river (the latter leaving the valley and reaching the high land again on the opposite line of the valley, near the mouth of Loggy Bayou), and continues to hug the east line of the valley to the mouth of Bayou Pierre, and thence to the head of Old River, better known now as Cane River. The valley has a varying width of about 6 miles. Bayou Pierre skirts the hills on the east and receives the water shed from the hills beyond, which divide the Red from the Sabine. It also receives the water of Red River at its head, but not until the stage of the latter is about 11 feet above low-water. Its sectional area at high-water is about 6,000 feet. Sand Beach Bayou leaves Red River 4 miles below Bayou Pierre and enters the latter after traversing the valley westward and southward a few miles. The high-water section of Sand Beach is nearly 2,000 square feet. Tone's Bayou has, we might say, a high-water area of 8,400 feet.

The cross-section of Red River at a point 400 yards above Scorpini's Cut-off is at high-water 13,000 feet. A few years ago the bayous on the east bank, having an aggregate area of about 3,500 feet, were closed; but I believe they were all cut during the recent high-water, about the time of the destruction of the main dam in Tone's Bayou. A section of Red River made near the Packery, about 2 miles below

Shreveport, gave a result of 24,200 feet in 1870, and in 1874 the se at the same place had increased to about 29,000 square feet.

From the above we see that before reaching Scorpini's Cut-off have lost a sectional area of discharge of about 16,000 square feet. volume of water having found its way to Bayou Pierre and Sand Be Bayou on the right, and the other bayous on the left, Tone's Bayou further depletes the river, so that below Scorpini's Cut-off, the ri which formerly was sufficiently large to carry off the water, is rowed in width and depth, and is known by the name of the "Na River."

It was at first intended to build a low-water dam in the bayou, as the narrow river enlarged from the increased volume of water thr into it, to gradually raise the dam to the high-water mark. It found from the nature of the soil that more than unusual difficulty expense attended this work, and so it was resolved to effect the en closure at once. With the bayou closed it might reasonably be pected (with other aid in the way of cutting down the timber along banks) that the main river would enlarge sufficiently in the course couple of seasons to carry off the increased supply.

Great fear of disastrous overflow from the stoppage of water thro Tone's Bayou is felt by the planters on the river below the cut-off. do not think that this latter will cause as much trouble as anticipa

Bayous Pierre and Sand Beach, still open, would afford an outlet a large volume of water, and, with small levees along both banks, river would soon accommodate itself to the increased supply. The g eral level of Bayou Pierre is about 5 feet lower than the bank of River all the way down to Bayou Winsey, through which the wa enters the river again. The distance via the bayou between the he and foot is about 50 miles less than by way of Red River proper tween the same points. The sloping nature of the lands illustrates ease (both in the recent flood and in all previous high-water) w which the planters could have protected themselves on the river fr had Tone's Bayou been closed. Small inexpensive levees would ha accomplished the object, whereas the lands were flooded from the r by the water through Bayou Pierre and Tone's Bayou, and the level the rear lands made any attempt to protect themselves from that di tion fruitless.

Considering the two routes via Red River proper, or via Tone's Bay and Pierre and Winsey, all the advantages are decidedly on the si of the former, including the closing of Tone's Bayou. This matter h been reported upon by Major Howell and by myself, and the same co clusion reached. The reports thereon will be found in the Report the Chief of Engineers for 1873, page 628, and in that for 1879, pa graph 1, page 979. In addition to the advantages therein set off, closing Tone's Bayou, I consider that it ranks all other works of i provement from the raft to Alexandria, for, with the work complete all the water properly belonging to the river must, at low-water, flo in one channel from Cross Bayou at Shreveport to the head of the Atc afalaya. All outlets between these points have their beds 10 feet more above low-water line, and accordingly we would have good lo water navigation to Shreveport for any boats that could pass the fal of Alexandria.

The commercial value of the stream is all the government takes co nizance of, though in other respects the closing of the bayou would ad to the amount of products, by opening up and reclaiming vast tract of the most fertile lands in that section of country.

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Deeming, then, that the closing of the bayou will be for the best interests of the government, and for which the appropriations are made, it is still a question whether it be advisable to expend any money for the object in view in face of the determined opposition of the people in the vicinity to having the work of the government carried out, with the likelihood that such work if finished would be destroyed.

The former appropriations are as follows:

By act approved June 10, 1872, for removing raft	$150,000
By act approved March 3, 1873, for removing raft	80,000
By act approved June 23, 1874, for removing raft	50,000
By act approved March 3, 1875, for removing raft	20,000
By act approved August 14, 1876, for removing raft and closing Tone's Bayou.	35,000
Allotment August 27, 1877, for closing Tone's Bayou	4,500
By act approved February 7, 1878, for removing raft	6,000
By act approved June 18, 1878, for removing raft and closing Tone's Bayou	24,000
By act approved March 3, 1879, for removing raft and closing Tone's Bayou.	15,000
By act approved June 14, 1880, for removing raft and closing Tone's Bayou.	25,000
By act approved March 3, 1881, for removing raft and closing Tone's Bayou.	10,000

The appropriation of August 2, 1882, is for the improvement of Red River, including the above works.

The above work was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A., on the 30th of June, 1882.

Money statement.

July 1, 1881, amount available	$31,182 64
July 1, 1882, amount expended during the fiscal year, exclusive of outstanding liabilities July 1, 1881	6,761 93
July 1, 1882, amount available	24,420 71

COMMERCIAL STATISTICS.

Shreveport is the principal distributing point for Red River.

Number of steamboats running to Shreveport	20
Bales of cotton received from Upper Red River	14,500
Amount of cotton seed (sacks)	49,000
Tons of freight shipped above	4,000
Tons of freight shipped below	6,550
Cotton from below shipped to Shreveport	11,500
Cotton shipped from Shreveport to New Orleans	55,243
Sacks of cotton seed shipped from Shreveport to New Orleans	2,550
Sacks of cotton-seed cake shipped from Shreveport to New Orleans	20,630
Barrels of cotton-seed oil shipped from Shreveport to New Orleans	5,613
Sacks of cotton-seed meal shipped from Shreveport to New Orleans	8,023

In addition to large quantities of miscellaneous freight, hides and tallow, cattle, &c.

The above works are situated in the third collection district of Louisiana. The port of entry is New Orleans.

P 6.

REMOVING OBSTRUCTIONS FROM RED RIVER, LOUISIANA.

It was expected that the new boat, intended especially for the work in this river, and which under the contract should have been completed on the 2d of July, 1881, would be ready, at least for a short season's work; but in August, finding that there would not be sufficient time after the boat left the contractor's hands to procure the necessary outfit and do any work, I concluded to withdraw the Wagner from the Ouachita and send her into Red River; this was done, and the boat worked in that stream from August 15 to October 12.

The work was carried on in the lower reaches of the river below Alexandria, especially in the vicinity of the Rapions and the old Confederate raft; 834 snags, 380 shore snags, and one wreck were removed.

The report of Capt. E. F. White herewith will give the details of the operations.

The new snag-boat C. W. Howell was received in November last, and as it was then too late to put her in commission it was deemed unnecessary to purchase a complete outfit. I accordingly had her towed to Memphis and laid up for the remainder of the season.

During the coming year it is proposed to complete the outfit of the new boat, and send her to Red River for the purpose of removing the obstructions as heretofore; her necessary running expenses for eight months, repairs, &c., being $24,000.

As the work must necessarily be continuous, new obstructions coming into the stream each year, it is not necessary to submit detailed estimates.

As the appropriation this year is under the title of the "Improvement of Red River" and to the amount of $75,000, the necessary allotment for the removal of obstructions can be taken therefrom.

On the 30th of June the above amount was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A.

The former appropriations are as follows:

By act approved June 18, 1878	$25,000
By act approved March 3, 1879	22,500
By act approved June 14, 1880, including cost of snag-boat	60,000
By act approved March 3, 1881	10,000

The above works are situated in the third collection district of Louisiana. The port of entry is New Orleans.

On June 30 the above work was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A.

Money statement.

July 1, 1881, amount available	$42,723 19
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	41,276 43
July 1, 1882, amount available	1,446 76

COMMERCIAL STATISTICS.

	Value.
Cotton, 135,557 bales	$6,777,850
Cotton seed, 121,210 sacks	85,000
Miscellaneous, cattle, &c	219,215
Return freights, plantation supplies, &c	1,742,150
Total	8,824,215

REPORT OF CAPTAIN E. F. WHITE.

UNITED STATES SNAG-BOAT O. G. WAGNER,
November 1, 1881.

MAJOR: I have the honor to submit herewith my report on the operations of the snag-boat O. G. Wagner, in the Red River, from August 15 to October 12, 1881.

Before entering upon the duties of removing obstructions to navigation in Red River, I received a number of communications from steamboat men engaged in that river, informing me that the channel through the Rapions was almost impassable, and needed especial attention.

I immediately proceeded to the foot of the Rapions and commenced operations. I found that the channel had shifted from the east to the west bank, which brought into the river a great many stumps and shore snags that had been entirely out of the way before. After the removal of the snags through the Rapions there was good low-water navigation.

My programme for working the river was to remove any and all obstructions to low-water navigation on my way up the river, but owing to the short season we had and the number of obstructions the work was confined from the foot of the Rapions to Ware's Landing.

Work throughout was very heavy, especially through the Rapions, where certain logs and snags could only be removed with the aid of heavy purchase blocks, rigged up on shore. Among other obstructions removed was an old flat-boat lying directly in the low-water channel just below "Double Eddy." The number of snags, logs, and stumps destroyed and removed from the channel during the present season in this river was as follows: 834 snags, 380 shore snags, one wreck of flat-boat.

I am pleased to state that the parties engaged in the navigation of Red River have expressed their entire satisfaction with the successful operations of the snag-boat O. G. Wagner during the past season.

Very respectfully, your obedient servant,

E. F. WHITE,
Commanding Snag-boat O. G. Wagner.

Maj. W. H. H. BENYAURD,
Corps of Engineers, U. S. A.

P 7.

IMPROVEMENT OF UPPER RED RIVER FROM FULTON, ARKANSAS, TO THE HEAD OF THE RAFT.

The work accomplished during the two previous seasons on this section of the river placed it in a good navigable condition when there was sufficient water for the boats to run, so that no appropriation was asked, nor was any work done during the past season, except as the steamer Florence went through. As stated in my last report, the work is not permanent, as each flood brings down new obstructions, and it was expected that appropriations would have to be made from time to time to keep the river clear.

The flood of last year in the Red River was the greatest that we have any reliable record of, and the reports show that the banks are caving very rapidly in the upper reaches, and the trees that have fallen in will have to be removed during the coming season.

With the balance of the old appropriation left, and with an allotment from the new appropriation, which includes the river from Fulton to the mouth, the needful work can be done.

The former appropriations are as follows:

By act approved March 3, 1879	$10,000
By act approved June 14, 1880	10,000

This work was transferred to Capt. A. M. Miller on the 30th of June.

Money statement.

July 1, 1881, amount available	$4,759 34
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	1,885 15
July 1, 1882, amount available	2,874 19

ESTIMATES FOR CLOSING CERTAIN OUTLETS OF THE RED RIVER, LOUISIANA.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., April 4, 1882.

GENERAL: In accordance with instructions contained in your letter of March 14, I have the honor to present the following estimates for closing several outlets of Red River, above Shreveport, as called for by the resolution of the Senate of the United States of March 10, 1882.

The outlets mentioned are known as the canals of Alban, Hervey, Sale and Murphy, and Kountz, and are situated in what is known as the raft region. They divert from the river a considerable volume of water at various stages that inundates the adjacent country. Their closure would tend to improve the navigation of the stream through that entire reach, but they would not *alone* entirely reclaim the land, from the fact that the floods of Red River at the localities in question, go above and entirely over the banks, and, therefore, for the accomplishment of the latter object, we would, in addition, have to build a continuous line of levee along both banks of the river.

Were the river at all points, except at the outlets, confined within banks, the closure of these outlets could be effected by comparatively inexpensive earthen dams, but in the present condition of affairs, as these would certainly be destroyed by the water running over them, it is necessary that the dams be constructed of more resisting material. I have, therefore, furnished estimates for the construction of dams of brush and stone, with mattress protection on bottom and sides to resist the scouring effect of the water.

The following are the estimates for the entire work:

SALE AND MURPHY'S CANAL.

Mattress protection on bottom and sides, including ballast	$1,800
1,000 cords brush, at $2.50 per cord, in place	2,500
400 yards stone, at $4	1,600
Contingencies, superintendence, &c	1,000
	6,900

ALBAN'S CANAL, NO. 1.

Mattress protection on bottom and sides, including ballast	$700
130 cords brush, at $2.50 per cord, in place	325
50 yards stone, at $4	200
Contingencies, superintendence, &c	250
	1,475

ALBAN'S CANAL, NO. 2.

Mattress protection on bottom and sides, including ballast	$1,440
450 cords brush, at $2.50 per cord, in place	1,125
200 yards stone, at $4	800
Contingencies, superintendence, &c	500
	3,865

*ALBAN'S CANAL, NO. 3.

Mattress protection on bottom and sides, including ballast	$1,200
280 cords brush, at $2.50 per cord, in place	700
150 yards stone, at $4	600
Contingencies, superintendence, &c	400
	2,900

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* Usually known as Stanton's Slough.

HERVEY'S CANAL.

Mattress protection on bottom and sides, including ballast	$1,080
250 cords brush, at $2.50 per cord, in place	625
150 yards stone, at $4	600
Contingencies, superintendence, &c	300
	2,605

KOUNTZ'S CANAL.

Mattress protection on bottom and sides, including ballast	$1,100
250 cords brush, at $2.50 per cord, in place	625
150 yards stone, at $4	600
Contingencies, superintendence, &c	300
	2,625

RECAPITULATION.

Sale and Murphy's Canal	$6,900
Alban's Canal, No. 1	1,475
Alban's Canal, No. 2	3,865
Alban's Canal, No. 3 (Stanton's Slough)	2,900
Hervey's Canal	2,605
Kountz's Canal	2,625
	20,370
Cost of outfit, consisting of flat-boats, tools, barrows, &c., which can be moved from one location to another, and used for each work	2,000
Total	22,370

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

P 8.

IMPROVING YAZOO RIVER, MISSISSIPPI.

The work of removing the snags and other obstructions from the Yazoo River was continued during the season with the snag-boat John R. Meigs.

The following is a summary of the work:

534 snags removed.
73 shore snags destroyed.
172 heavy trees cut down.
Wreck of steamer Carrie Hogan removed.

When the work in the Yazoo was suspended the Meigs was taken to Memphis and transferred to Capt. T. H. Handbury, Corps of Engineers, for work in his district.

With the appropriation asked for for the fiscal year ending June 30, 1884, it is proposed to continue the work as heretofore.

The estimated cost of running a snag-boat in the river for eight months' work and incidental repairs, &c., is $24,000.

The former appropriations are as follows:

By act approved March 3, 1873, applied to the removal of eleven wrecks sunk in the stream during the late war	$40,000
By act approved March 3, 1875	12,000
By act approved August 14, 1876	15,000

By act approved June 18, 1878	$25,000
By act approved March 3, 1879	15,000
By act approved June 14, 1880	12,000
By act approved March 3, 1881	6,000
By act approved August 2, 1882	8,000

On June 30 the above work was transferred to Capt. A. M. Miller. Corps of Engineers, U. S. A.

Money statement.

July 1, 1881, amount available	$4,733 85
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	4,427 54
July 1, 1882, amount available	306 31
Amount appropriated by act passed August 2, 1882	8,000 00
Amount available for fiscal year ending June 30, 1883	8,306 31
Amount that can be profitably expended in fiscal year ending June 30, 1884	24,000 00

COMMERCIAL STATISTICS.

	Value.
Cotton, 69,000 bales	$3,450,000
Cotton-seed, 55,000 sacks	27,500
Miscellaneous products, return freights, &c	1 700,000
Total	5,177,500

The Yazoo River is in the collection district of Vicksburg, Miss. The port of entry is New Orleans, La.

P 9.

IMPROVING BIG SUNFLOWER RIVER, MISSISSIPPI.

For work on this river last season a party was organized with camping outfit, &c., and part sent to the upper section of the river, with a view of opening the same to navigation, so as to afford the planters of that section the means of transporting their crops by river, either down to Vicksburg or up to the railroad and thence to the Mississippi.

Operations were commenced at Clarksdale and continued downstream for some distance, when instructions were sent for the party to start in at Faisonia and work up. This stretch of river from Faisonia to Dougherty's Ferry was cleared of all obstructions.

As it was found necessary to repair some of the wing-dams built at the shoal places the previous year, the work was transferred September 15 to the lower portion of the river, and the dams at Callao and Vick's Landing were repaired and new ones constructed at Shell Ridge.

After the dams were completed the work of removing logs, stumps, &c., was continued between Grassy Mound and Campbellsville until October 27.

The following is a summary of the work done on the river during the season:

20,245 leaning trees cut down.
134 trees deadened.
186 logs removed.
250 feet of wing-dam constructed at Callao.
225 feet of wing-dam constructed at Shell Ridge.
300 feet of wing-dam constructed at Vick's Landing.

In addition to the above, a large quantity of smaller timber, not counted as trees, was removed.

The report of Mr. John J. Barry, herewith, will give the details of the work.

The work in the lower river next season will require the use of a steamer, as the snags are so heavy and so deeply imbedded in the mud that they cannot be removed otherwise. Several wing-dams will also be needed near Faisonia and at Oliphant's Bar, to concentrate and deepen the water over the bars at those places, and the appropriation of August 2, 1882, will be expended in doing this work.

With the appropriation of $15,000 asked for for the fiscal year ending June 30, 1884, the same work will be continued.

The estimated cost of this improvement was $66,000.

The former appropriations are as follows:

By act approved March 3, 1879	$20,000
By act approved June 14, 1880	8,000
By act approved March 3, 1881	4,000
By act approved August 2, 1882	5,000

COMMERCIAL STATISTICS.

	Value.
Cotton, 20,000 bales	$1,025,000
Cotton-seed, 18,500 sacks	9,250
Miscellaneous products	15,000
Return freight, plantation supplies, &c	523,000
Total	1,572,250

For port of entry and collection district see report for improving Yazoo River, Mississippi.

On June 30 the above work was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A.

Money statement.

July 1, 1881, amount available	$4,264 49
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	2,909 87
July 1, 1882, amount available	1,354 62
Amount appropriated by act passed August 2, 1882	5,000 00
Amount available for fiscal year ending June 30, 1883	6,354 62
Amount (estimated) required for completion of existing project	29,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	15,000 00

REPORT OF MR. JOHN J. BARRY, ASSISTANT ENGINEER.

MEMPHIS, TENN., *December* 1, 1881.

MAJOR: I have the honor to make the following report of the operations carried on under your instructions on the Big Sunflower River, Mississippi, during the season of 1881.

After procuring the proper outfit necessary to the success of the work I was to be engaged in, I proceeded to Clarksdale, situated on the bank of the Big Sunflower, and commenced operations at once. I found the river full of obstructions, principally leaning timber, and a great many snags. The river was extremely low and of a contracted nature, its average width being not more than 40 yards, thus making the obstructions more in the way than would have been the case had the stream been of proper width, as the channel proper had to form on one bank or the other, compelling steamers to navigate in a narrow space, as the channel in rivers of this peculiar nature is the only place where any depth of water is likely to be found during low-water navigation.

After cutting timber and removing various other obstructions up to the 24th of June, I was, under instruction, transferred to the head of low-water navigation, and there commenced operations upstream, removing leaning timber, snags, logs, and other obstructions that nature forms in streams that have no rapid outlet during low-water.

The river from the head of low-water navigation upstream is very crooked, having short bends and sharp points, all of which were full of leaning timber that made it very unsafe for steamers of any dimensions to navigate with anything like safety. This was all removed for a distance of 100 miles, or from Faisonia, the head of low-water navigation, to Dougherty's Ferry, the principal upper landing. The timber was cut short and well trimmed, so as to prevent its forming a jam on the way out, and steamers can now safely navigate that portion of the river without any fear of damage, and can make an average of two days' saving of time in the transportation of the productions of the upper portion of the river at any reasonable stage of water, or what would be considered a reasonable stage for that portion of the river.

The operations continued upstream until the 15th of September, when, under instructions from you, I was transferred to the lower portion of the river, where steamers were having considerable trouble.

As instructed, I consulted with the principal steamboat officers navigating this portion of the river, and found that their great trouble was caused by "bars" which had formed across the channel at Callao, Shell Ridge, and Vick's Landing. These different places had almost entirely obstructed navigation, it requiring from 6 to [illegible] hours' constant hard pulling at Callao and the same at Shell Ridge to make the crossing of the "bar," while at Vick's Landing it consumed an entire day to travel 100 yards.

These bars were removed by the construction of wing-dams, and steamers now have no trouble in passing those places. Where they had 2 feet of water they now have from 3 to 3½ feet.

After completing the dams, I moved to Grassy Mound, 33 miles from the mouth of the river, removing 31 obstructions, consisting of logs, stumps, tree-tops, &c., and on the 27th of October arrived at Campbellsville, under orders to proceed with my outfit to Delta, La., and store it at the government storehouse for future use, as the backwater from the recent rises in the upper river prevented any further operations in the lower portion of Big Sunflower, and a lack of funds from completing what was necessary to be done in the upper portion.

The following is the amount of work done:

20,245 leaning trees cut down.
134 trees deadened.
186 logs removed.
250 feet of dam built at Calloa.
225 feet of dam built at Shell Ridge.
300 feet of dam built at Vick's Landing.

There was also a large quantity of smaller timber removed that was not entered on the "log," but was just as necessary to the successful opening of navigation as larger ones, and required both time and labor in their destruction.

There are a number of places in the river that are sadly in need of attention. There are also a great many snags to be removed, but it is almost a waste of time to undertake their removal without the aid of steam, as the concentration of muscular power, aided by lines, blocks, &c., no matter how well regulated, is only sufficient to remove the lighter ones, and these generally are least in the way.

There are several "bars" to be removed near Faisonia, and some improvements at Oliphant's Bar, and unless made, there is a strong probability of a serious interruption of navigation during the next low-water season, thus depriving the people of that portion of the river of a proper outlet for the productions of the country, and almost entirely isolating them from intercourse with the markets in the outside world.

Very respectfully, your obedient servant,

JOHN J. BARRY.

Maj. W. H. H. BENYAURD,
Corps of Engineers, U. S. A.

P 10.

IMPROVEMENT OF TALLAHATCHIE RIVER, MISSISSIPPI.

The work of removing obstructions from the Tallahatchie River was continued last season with the plant provided on former occasion.

The river was very low on the upper reach, between Batesville and the mouth of the Coldwater, and in some places it was completely blocked up with drift. A channel wide enough for boats to pass in a good stage of water was cut through these obstructions. On the lower river the steamboat men complained of having trouble at Pecan Point.

The reach of river in this vicinity was completely cleaned out.

The work was continued from July 1 to about the middle of September, during which time 457 snags and logs were removed from the channel and a number of leaning trees cut down.

There is still a considerable amount of work to be done on the lower part of the Tallahatchie in order to place it in a good navigable condition at all stages of water. The appropriations, however, have been so small that we have heretofore only attempted to take out the worst obstructions.

On the stretch of river between Batesville and the mouth of the Coldwater I do not think it advantageous, in a commercial view, to expend any more money. There has not been a boat on this section of the river since the war. I doubt, even if the river was improved, that boats could be induced to run.

The estimated cost of the improvement of the Tallahatchie River proper, not including the stretch of river last referred to, was $40,000.

The former appropriations are as follows:

By act approved March 3, 1879	$6,000 00
By act approved June 14, 1880	9,000 00
By act approved March 3, 1881	3,000 00
By act passed August 2, 1882	3,000 00
Amount expended up to close of the fiscal year ending June 30, 1881	16,420 22

On the 30th of June the above work was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A.

For commercial statistics see report on the Yazoo River.

Money statement.

July 1, 1881, amount available	$1,579 78
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	1,579 78
Amount appropriated by act passed August 2, 1882	3,000 00
Amount (estimated) required for completion of existing project	19,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	10,000 00

P 11.

IMPROVEMENT OF COLDWATER RIVER, MISSISSIPPI.

No appropriation was made for this stream last year, and none was asked for. The upper portion of the river is obstructed for miles by solid jams, and the lower portion runs through a very thinly settled country, which would not warrant the expenditure of so large a sum of money as would be necessary to put the river in a good navigable condition.

The former appropriations are as follows:

By act approved March 3, 1879	$7,000 00
By act approved June 14, 1880	4,000 00
Amount expended up to close of the fiscal year ending June 30, 1881	8,835 80

On the 30th of June, 1882, the above work was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A.

more than 6 feet of water, these snags will prove no further obstruction until the sand-bars are removed, when they will also have to be cut down.

There were some sawyers, or logs which rise with the water; these I did not cut, as they would prove a worse obstruction than they were before if they could not be seen. If I had had some rope I might have been able to have pulled some of them out of the way.

There are three large sand-bars in the lake, one at the head, one about 20 miles below the head, and the third about 50 miles, this latter one being about 1¼ miles long.

During low-water these could be leveled 3 or 4 feet by hand, and would give navigation in the lake at a stage at least 3 feet lower than boats usually run now.

We reached the foot of the lake on September 8, where I disbanded my party and disposed of my property as you directed.

The result of this season's work will be that boats will be able to navigate the lake without any danger to their upper works, which before were being continually damaged and knocked overboard, and they also can go through on a stage of water from 1 to 2 feet lower than before, on account of the snags that were removed.

The following represents the amount of work done during the season:

Number of trees cut down during July	3,884
Number of trees deadened	1,418
Number of snags cut	441
Number of trees cut down during August	4,493
Number of trees deadened	1,006
Number of snags cut	202
Number of trees cut down during September	966
Number of trees deadened	64
Number of snags cut	43

RECAPITULATION.

Total number of trees cut down	9,363
Total number of trees deadened	2,588
Total number of snags cut	686

Very respectfully, your obedient servant,

H. C. WILSON,
Assistant Engineer.

COMMERCIAL STATISTICS.

It is estimated that about 20,000 bales of cotton are raised along the banks of Tchula Lake, about one-half of which is taken out by boats, the remainder being hauled to the Yazoo. Were the stream fully improved it is presumed that the entire amount would find its way out by boat.

P 13.

IMPROVEMENT OF THE YALLABUSHA RIVER, MISSISSIPPI.

This work was commenced in June of last year, 1881, and a flat-boat procured, with the necessary outfit. As the river could only be navigated at a medium stage of water, instructions were issued to remove only the worst obstructions, so that boats could run at that stage. During the season 540 snags and logs were removed, 694 trees destroyed, and 63 drift piles were removed.

The amount expended up to June 30, 1881, was $1,072.31, and during the year ending June 30, 1882, there was expended $2,427.69.

The appropriation of August 2, 1882, will be expended in carrying on the work as before, and with the amount asked for for the fiscal year ending June 30, 1884, it is proposed to work to the same end.

The estimated cost of the work is $7,000.

On the 30th of June, 1882, the above work was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A.

Money statement.

July 1, 1881, amount available	$2,427 69
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	2,427 69
Amount appropriated by act passed August 2, 1882	3,500 00

COMMERCIAL STATISTICS.

It is estimated that about 12,000 bales of cotton are raised along the Yallabusha, about 5,000 of which goes by boat to Vicksburg, the balance being taken to the railroad.

P 14.

IMPROVEMENT OF BIG HATCHIE, TENNESSEE.

The operations on this river have heretofore consisted in removing all obstructions to the safe navigation of the river. A flat-boat properly equipped was procured, and work done by hired labor. Operations were commenced at Bolivar and continued downstream to the mouth of the river, which point was reached October 15.

For the first 7½ miles below Bolivar the river was in fair condition, though it was necessary to remove a number of snags and also the wreck of the steamer Poitevant.

Through the next 56 miles the river was found to be in a very bad condition. In many places logs from 3 to 5 feet in diameter were found reaching from bank to bank.

Six miles below Brownsville the Louisville and Nashville Railroad had left the piling used in constructing their new bridge still standing in the draw passages. The piles were all cut off below low-water sufficient to afford a safe navigation. From this point out the river was found to be in a passable condition, though some work was found necessary at the cut-offs at Bond's Cliffs and Nelson's Landing. The old trestle-work at the bridge-crossing of the Paducah road was also removed.

The following is a summary of the work done:

Distance traveled, 213 miles.

Number of snags and logs removed	3,204
Number of trees cut down	636
Number of trees destroyed	656

Wreck of steamer Poitevant removed.

During the coming season it is proposed to continue the above work of improvement, and the appropriation asked for for the year ending June 30, 1882, will be expended in like manner.

The estimated cost of this improvement was $30,000.

The former appropriations are as follows:

Act approved June 14, 1880	$10,000 00
Act approved March 3, 1881	3,500 00
Act passed August 2, 1882	3,000 00
The amount expended to June 30, 1881, was	7,323 46

The above work was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A., on the 30th day of June, 1882.

Money statement.

July 1, 1881, amount available	$6,176 54
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	5,744 65
July 1, 1882 amount available	431 89
Amount appropriated by act passed August 2, 1882	3,000 00
Amount available for fiscal year ending June 30, 1883	3,431 89
Amount (estimated) required for completion of existing project	13,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	10,000 00

P 5.

IMPROVEMENT OF THE OUACHITA RIVER, ARKANSAS AND LOUISIANA.

Operations were continued upon this stream with the snag-boat O. G. Wagner until August 15, when she was withdrawn and sent into the Red River.

The work on the upper river consisted mostly in cutting down the leaning trees, which in places reached nearly across the river, and interfered greatly with the low water navigation. At Monroe the wreck of the old wharf-boat, lying directly across the low water channel in front of the city, was removed. Below Monroe the work was carried on as long as the stage of water would permit, and consisted in removing snags and logs from the channel.

From July 1 to August 15, 111 snags and logs were removed and 2,275 trees cut down, and during the whole season, from June 1 to August 15, 241 snags and logs were removed and 6,210 trees cut down. The report of Capt. C. F. White, herewith, will give the details of the work for the whole season.

No work was done at Catahoula Shoals last season.

During the coming season it is proposed to continue the work with the snag-boat, and the appropriation asked for for the fiscal year ending June 30, 1884, will be applied in the same manner.

No detailed estimates will be presented for the improvement of the Ouachita with the snag-boat, since the nature of the work must be continuous from year to year, owing to the character of the obstructions which each flood brings down.

The former appropriations are as follows:

By act approved March 3, 1871	$51,000
By act approved June 10, 1872	100,000
By act approved March 3, 1873	60,000
By act approved August 14, 1876	12,000
By act approved June 18, 1878	10,000
By act approved March 3, 1879	10,000
By act approved June 14, 1880	8,000
By act approved March 3, 1881	12,000
By act passed August 2, 1882	12,000

The first appropriations were made with a view to the improvement of the river by means of a system of locks and dams, the estimated cost of which was $1,163,083.75; also for operating with a non-propelling crane-boat.

A portion of the funds appropriated had been expended under this project for material, surveys, &c., when it was abandoned, and the balance of the funds was expended in the purchase of an iron hull snag-boat and in operating it upon the river.

The above work was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A., on June 30, 1882.

Money statement.

July 1, 1881, amount available	$7,582 89
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	5,871 38
July 1, 1882, amount available	1,711 51
Amount appropriated by act passed August 2, 1882	12,000 00
Amount available for fiscal year ending June 30, 1883	13,711 51
Amount that can be profitably expended in fiscal year ending June 30, 1884	16,000 00

COMMERCIAL STATISTICS.

The amount of freight carried during the year was as follows:

	Value.
116,544 bales cotton	$5,827,200
9,000 tons cotton-seed	90,000
242 bales hides	9,680
100 barrels cotton-seed oil	1,200
326,466 staves	26,080
2,000 head cattle	40,000
2,500 head hogs	15,000
3,000 barrels rice	45,000
400 head sheep	2,000
10,000 cords ash wood	50,000
Rafts of ash and walnut timber	500,000
Produce and sundries	90,000
Value of up freight, consisting of provisions, supplies, agricultural implements, and general merchandise	1,900,000
	8,596,160

REPORT OF CAPTAIN E. F. WHITE.

UNITED STATES SNAG-BOAT O. G. WAGNER,
November 1, 1881.

MAJOR: I have the honor to submit herewith my report on the operations of the snag-boat O. G. Wagner in the Ouachita River from June 1 to August 15, 1881.

Under date of May 12 I was instructed to fit out the Wagner for service, and proceed to Camden, Ark., the head of navigation on this river, and remove the snags and obstructions from the same, working downstream as the water fell.

Saturday, May 28 I made a trial trip with the boat to test the machinery, to see that everything was in working order.

Left New Orleans May 30 and proceeded to the mouth of Red River; arrived there Wednesday, June 1; left Thursday, June 2, and proceeded directly to Camden, Ark., where I arrived June 8, and commenced operations immediately. The most of the work done was confined to what is known as bank work, that is, cutting down leaning trees. In a number of places trees were found to extend two-thirds of the width of the river, and made the low water channel almost impassable, and in many places we were compelled to place rigging ashore and pull the trees out on the bank, after cutting them down, to prevent them from floating down the river and lodging on the different bars and shoals, thus obstructing the low water channel.

Special attention was paid to the bars and shoals, so as to keep navigation open from Monroe to Camden for the small craft navigating the river during low water.

At Spoon Camp I noticed that the dam constructed by Mr. Justin Straszer in 1877 was in good condition, and answering the purpose for which it was placed there, turning the water of the river into one channel. At the head of the island I found a log at right angles to the channel, and imbedded in the sand, after the removal of which, with five other logs, the depth of water in the channel at the foot of the island was increased from 30 to 36 inches. At Buffalo Flats we removed five logs at the head of the island, after the removal of which the depth of water was increased from 6 to 24 inches, allowing the water to flow more rapidly, thus cutting a channel through.

I would most respectfully recommend that a dam be constructed across the head of the island similar to the one built at Spoon Camp.

The obstructions were specially prominent at the following localities: Point opposite Camden, Preddway's, McMahon's, Whitehall, Blue Beach, Spoon Camp, Buffalo Flats, Champagnolle, Wilmington, Bang's Landing, New London Landing, Brinker's, Perro-Geese Shoals, Marie Saline, and Bayou Lapeal.

The water becoming too low to work above Monroe, I proceeded to that point and reported to you by letter, receiving instructions to continue the work below Monroe until further orders.

Monday, July 11, commenced on the wreck of the wharf-boat sunk in front of the city and directly across the low water channel, making it almost impossible to pass her during low water. Saturday, July 16, finished removing the wreck and moved down in front of Muir's saw-mill, and removed 13 logs, which were very dangerous obstructions to navigation.

I would most respectfully call your attention to the following parts of the river, as they need working very much, namely, between Monroe and Fenner's Bar, and between the last-named bar and Mansfield. Owing to the river falling so fast, I was unable to remain long enough to complete the work at these places. The work between Monroe Bar and Fenner's Bar can be done only in extreme low water.

The number of snags, logs, and stumps destroyed and removed from the channel the present season amounts to 241, and the number of trees cut down to 6,210. The wreck of the old wharf-boat was also removed entirely from in front of the city of Monroe.

Operations in Ouachita River should be carried on in the same manner next season, for while great improvements have been made, a great deal yet remains to be done, principally cutting down leaning trees on the river bank above Monroe and removing snags below.

Among the old steamboat wrecks still remaining in the river I consider as the worst the wreck of the Henry Homeyer, lying directly in front of the Falk place, and 3 miles above Taylor's Bar, and the Dr. Beattie, sunk in front of Medway's plantation, and about 6 miles below Taylor's Bar. The latter is a very dangerous obstruction at night.

I received orders August 12 to withdraw from the Ouachita and proceed to Red River.

I am pleased to state that parties engaged in the navigation of this river have expressed their entire satisfaction with the operations of this boat during the last season.

Very respectfully, your obedient servant,

E. F. WHITE,
Commanding United States Snag-boat O. G. Wagner.

Maj. W. H. H. BENYAURD,
Corps of Engineers, U. S. A.

P 16.

IMPROVEMENT OF BAYOU BARTHOLOMEW, LOUISIANA AND ARKANSAS.

As the lower reaches of the bayou are navigated by the Ouachita River boats, it was decided to commence operations on the upper part of the river, so as to open the entire bayou to navigation at a time when a sufficient depth of water existed for them to run. For this purpose a working party properly equipped was sent to Baxter Station, at the bridge-crossing of the Mississippi and Texas Railroad, with instructions to work from that point downward.

The upper part of the bayou was in a very bad condition, being narrow, crooked, and full of snags and stumps. Considerable difficulty was also experienced in keeping a full working force on account of prevailing malarial fever. However, the force worked from the 20th of July until the 25th of December, when the high stage of water put an end to operations for the season. During this period the following amount of work was accomplished:

3,937 leaning trees cut down.
6,017 logs removed.
5 drift piles destroyed.
4 bends cleared of obstructions.
1 wreck of barge removed.

During the coming season it is proposed to continue the work of clearing all obstructions from the bed and banks of the stream, and with the appropriation asked for, for fiscal year ending June 30, 1884, the improvement of the bayou will be continued in the same manner.

The estimated cost of the work was $26,862.

The present appropriations are as follows:

By act approved March 3, 1881	$8,000 00
By act passed August 2, 1882	5,000 00
Amount expended to end of fiscal year ending June 30, 1881	142 65

On the 30th of June I transferred the above work to Capt. A. M. Miller, Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

It is estimated that upwards of 25,000 bales of cotton are raised in the vicinity which would find its way out by steamboat were the bayou thoroughly improved.

The work is in the collection district of New Orleans.

Money statement.

July 1, 1881, amount available	$7,857 15
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	7,274 89
July 1, 1882, amount available	582 26
Amount appropriated by act passed August 2, 1882	5,000 00
Amount available for fiscal year ending June 30, 1883	5,582 26
Amount (estimated) required for completion of existing project	13,862 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	14,000 00

P 17.

IMPROVEMENT OF TENSAS RIVER, LOUISIANA.

Operations upon this stream commenced in September last with an appropriation of $3,000. As this amount was not sufficient to provide much of an outfit and then do any work, a flat-boat was fitted out with saws, axes, and all the necessary tools for carrying on the operations.

A party was organized and instructed to commence the work at Dallas, La., where the Vicksburg, Shreveport and Pacific Railroad crosses the river, and to work downstream.

The principal part of the work was cutting down the leaning trees along the banks, and these were either hauled out upon the banks or cut up into such lengths that they would not again prove an obstruction. A number of logs and some snags were also found, all of which were removed as the party proceeded downstream.

Operations continued until the end of December, and during the season the following work was done:

697 trees cut down.
146 trees topped.
403 logs removed.
292 snags pulled out.

The estimated cost of this work was $23,000.

The former appropriation is as follows:

By act approved March 3, 1881, $3,000.

On June 30, 1882, the above work was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A.

Money statement.

July 1, 1881, amount available	$3,000
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	3,000
Amount (estimated) required for completion of existing project	20,000

COMMERCIAL STATISTICS.

Amount of freight carried during the season:

6,000 bales cotton, valued at	$300,000
2,000 tons cotton-seed	20,000
Miscellaneous products	8,977
Value of up freight, plantation supplies, &c	103,431
Total	432,408

The work is in the collection district of New Orleans.

P 18.

IMPROVEMENT OF BAYOU BOEUF, LOUISIANA.

The work of improving this stream was commenced in August, 1881, for which purpose a flat-boat was provided with the necessary outfit for the work of removing the ordinary obstructions to navigation.

The work was started at Jefferson, La., and carried on downstream as far as the available funds would permit.

The following is a summary of the work:

1,945 leaning trees cut down.
960 snags and logs removed.
359 stumps removed.
7 rock-heaps destroyed and bends cleared of timber, &c.

During the coming season the work will be continued in the same manner, and the appropriation asked for will be applied to the same purpose.

The estimated cost of the work was $20,000.

The former appropriations were:

By act approved March 3, 1881	$5,000
By act passed August 2, 1882	5,000

The above work was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A., on the 30th of June, 1882.

Money statement.

July 1, 1881, amount available	$5,000
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	5,000
Amount appropriated by act passed August 2, 1882	5,000
Amount (estimated) required for completion of existing project	10,000
Amount that can be profitably expended in fiscal year ending June 30, 1884	10,000

COMMERCIAL STATISTICS.

2,795 bales of cotton, valued at	$139,750
2,500 pounds cotton-seed	2,500
Miscellaneous products, stores, cattle, hides, &c	17,438
Value of return freight, plantation supplies, &c	62,700
Total	222,388

The work is in the collection district of New Orleans.

P 19.

IMPROVEMENT OF CYPRESS BAYOU, TEXAS AND LOUISIANA.

The project for the improvement of Cypress Bayou contemplated the cutting out and dredging a channel through the lakes and bayou. This work was completed in 1880, and has resulted in giving good high water navigation between Jefferson, Texas, and Red River, in Louisiana.

No work was done on the bayou last season.

The property was taken care of by the watchman, and several repairs of one kind and another were made. The dredge-boat belonging to this work was used at the mouth of Red River.

As stated in my report for 1880, should further improvement be desired, it would require extensive works, such as recommended by Major Howell; that project being to construct a dam across the lakes at Albany Point, and make a cut through to Red River. No appropriation has been made therefor.

This would give Jefferson navigable water nearly all the year round, and would greatly benefit Red River above and below Shreveport, but if the work should be once begun the amount of money required should be made available in one appropriation for the successful execution of this work.

The former appropriations are as follows:

By act approved June 10, 1872	$10,000
By act approved March 3, 1873	50,000
By act approved August 14, 1876	13,000
By act approved June 18, 1878	15,000
By act approved March 3, 1879	6,000
Amount expended to end of fiscal year ending June 30, 1881	91,190

The above work is in the collection district of New Orleans.

On June 30 the above work was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A.

Money statement.

July 1, 1881, amount available	$2,810 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	225 42
July 1, 1882, amount available	2,584 58

P 0.

WATER GAUGES ON THE MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

Observations were continued at all the gauge stations during the year, and repairs made to those at Helena, mouth of White River, Red River Landing, Nashville, and Florence. The bulletin boards established last year, recording each morning the stage of water for the benefit of passing steamboats, were found to be of great service.

Records of the daily readings of the gauges were furnished the Mississippi River Commission.

The flood of the past spring was the highest ever known at various points on the Mississippi, and also on the Cumberland; and accordingly new high water marks were established on the latter stream at Nashville, and on the former at Cairo, Memphis, Helena, mouth of White River, and Red River Landing.

The following table gives a comparison of this flood with the highest water previously recorded at the different stations.

Hydrographs of all gauges were plotted for us in the office.

Copies of the gauge records at all the stations for the year are transmitted herewith.

In accordance with joint resolution approved February 21, 1871, the sum of $5,000 is appropriated annually for the gauges.

On June 30 the above work was transferred to Capt. A. M. Miller, Corps of Engineers, U. S. A.

Money statement.

July 1, 1881, amount available	$6,511 10
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	5,751 81
July 1, 1882, amount available	759 29
Amount appropriated by act passed August 2, 1882	5,000 00
Amount available for fiscal year ending June 30, 1883	5,759 29
Amount that can be profitably expended in fiscal year ending June 30, 1884	5,000 00

Comparison of flood of 1882 *with highest water previously recorded at the gauge stations on the Mississippi and tributaries.*

Stations.	Highest water previously recorded.		Highest water of 1882 to June 30.		Excess over previous highest records.
	Year.	Gauge reading.	Date.	Gauge reading.	
		Feet.		*Feet.*	*Feet.*
Cairo	1867	50.97	Feb. 26	51.87	0.90
Memphis	1862	34.45	Mar. 6 Mar. 9	35.15	0.70
Helena	1862	46.40	Mar. 9	47.20	0.80
Mouth of White River	1862	48.20	Feb. 28	48.40	0.20
Lake Providence	1862	40.87	Mar. 20	38.32	*— 2.55
Vicksburg	1862	51.10	Mar. 20 Mar. 21	48.75	— 2.35
Natchez	1862	50.30	Mar. 28 Mar. 29	47.75	— 2.55
Red River Landing	1874	47.00	Mar. 27	48.50	1.50
Baton Rouge	1874	36.15	Mar. 26	35.95	— 0.20
Carrollton	1862	15.90	Mar. 27	14.95	— 0.95
St. Louis	1844	41.39	Feb. 22	28.20	—13.19
Louisville (upper)	1832	40.76	Feb. 22	37.40	— 3.36
Louisville (lower)	1832	67.50	Feb. 22	63.00	— 4.50
Fort Leavenworth	1867	22.06	Apr. 18	14.60	— 7.46
Nashville	1847	54.67	Jan. 22	55.30	0.63
Florence	1867	31.08	Jan. 21	30.00	— 1.08
Jacksonport	1867	32.83	May 11	31.20	— 1.63
Little Rock	1857	31.00	Feb. 25	25.70	— 5.30
Alexandria	1866	36.46	Mar. 18	34.85	— 1.61

* The minus (—) sign denotes that the high water of 1882 was below the highest water previously recorded.

P 21.

EXAMINATION OF BEAR CREEK, RUNNING INTO YAZOO RIVER, MISSISSIPPI.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., December 10, 1881.

GENERAL: I have the honor to submit the following report on the examination of Bear Creek, Mississippi, made, under my direction, by Mr. Walter S. Davis, assistant engineer, as called for by the river and harbor act of March 3, 1881.

This stream, which is a tributary of the Yazoo, lying between that stream and the Big Sunflower, consists of a series of small lakes connected by narrow branches, and is in length about 90 miles. At low-water the lakes and branches are totally unnavigable, and are designated by Mr. Davis as nothing more than stagnant ponds. When a rise occurs in the Yazoo, Bear Creek and its connecting lakes are filled by back and head water from that stream, sufficient in volume to render the channel navigable for upwards of five months in the year, or during the continuance of a moderately high stage of water in the Yazoo.

It is only during this period that any improvement would be of service, giving to the planters in that immediate section the means of shipping their products down the stream, instead of hauling to the Yazoo landings.

The improvement of Bear Creek would consist simply in cutting out sufficient timber, &c., to give a good high-water channel for such small steamers as might navigate the stream. The estimated length of such a channel through the creek proper and lakes is 44 miles; and the estimated cost of the work is placed at $6,000.

The value of the products shipped via Bear Creek during the season of 1880 is estimated by the planters on the stream at $71,600.

Very respectfully, your obedient servant,
W. H. H. BENYAURD,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. WALTER S. DAVIS, ASSISTANT ENGINEER.

MEMPHIS, TENN., *September* 30, 1881.

MAJOR: In accordance with your instructions to make an examination of Bear Creek, Mississippi, I have the honor of submitting the following report:

Bear Creek, rising in Mosquito Lake, Leflore County, and flowing 90 or 100 miles through Leflore, and parts of Sunflower and Washington counties, in a southerly direction, forming the connecting link of a chain of small lakes, empties into Wasp Lake, and through Wasp Lake into Yazoo River.

It lies entirely between the Yazoo and Sunflower rivers.

On the 14th of July, 1881, with two light skiffs, camp outfit, and with two experienced skiffmen and a cook, I commenced at the mouth of Wasp Lake the ascent of Bear Creek.

Wasp Lake is 8 miles long, from 80 to 300 feet wide, and from 2¼ to 11 feet deep at the present stage of water, which was, I learn, very low. Its banks are from 10 to 20 feet high, and very gradually sloping, never caving nor sliding, and are covered with a growth of scrubby swamp elm near the water's edge, and 150 feet up the slope. Beyond this low growth are large forests of oak, gum, hickory, and pecan, interspersed with numerous cypress brakes, varying in size from 1 to 1,000 acres, and containing lumber of the best quality.

There is a steam saw-mill at the mouth of Wasp Lake, and one 4 miles higher up;

both constantly engaged in sawing lumber that, during high-water, is rafted down Bear Creek.

The soil on both sides of Wasp Lake, and in fact to the head of Bear Creek, is rich alluvial and very productive.

With the exception of two hundred trees to be cut on Willow Point, and twenty-five large cypress trees at its head, Wasp Lake requires no work to make it navigable during high-water.

After leaving Wasp Lake I found Bear Creek proper very shallow and sluggish. Its bed is of soft blue mud, its banks low and frequently marshy. A few hundred feet on each side of the creek the ground abruptly rises, forming what are known as "second banks." In this basin or large channel the creek meanders from bank to bank, frequently widening out into shallow lakelets that are hardly more than stagnant pools. Some of these are from 200 to 300 feet wide, and so shallow that we were forced to wade and drag our skiffs along through soft mud and shallow water.

The "second banks" mentioned above continue almost the entire length of the creek. So small is the fall from its source to its mouth, that as soon as the Yazoo River rises a few feet it backs its water up the creek, giving it the appearance of a long lake from 300 to 600 feet wide, and entirely within the second banks. As the river rises it continues to back up the creek until it reaches a distance of 40 miles from its mouth, when the river breaks through above and flows down the creek; then it has a current nearly equal to that of the river.

I learn that for five months in the year Bear Creek is from 8 to 15 feet deep. This information is corroborated by well-defined water-marks upon the trees along the banks. It is therefore only fit for navigation during the winter and earlier part of spring, a time when the country lying between Bear Creek and the rivers Yazoo and Sunflower is so boggy that the planters living upon the creek are forced to ship their produce down in flat-boats, or by the Evergreen, a small stern-wheel boat that makes a few trips in the creek in winter, carrying at a trip 100 bales of cotton, cotton-seed, &c.

For 8 miles up the creek (16 miles from mouth of Wasp Lake) to Cattlings the timber was cleared within second banks about twenty-five years ago, and now in its stead there is a small scrubby growth of swamp-elm principally, as mentioned above. I was informed that some of the largest Yazoo River boats have run up to this point, and that during the war gunboats with their transports came here.

To improve the creek to Cattlings it is only necessary to cut or girdle the trees on the inner sides of bends. Above Cattlings the growth is heavier, consisting principally of bitter pecan and cypress. In the summer of 1880, some citizens, beginning at Cattlings, cut an avenue 50 feet wide up the creek (within "second banks," ignoring the present small channel of 30 feet and running as nearly straight as possible) for a distance of 15 miles to the head of Six Mile Lake. They simply cut the trees down, leaving them matted across the creek so thick as to stop our progress in skiffs entirely. The cost of cutting this avenue was $600. Last winter the fallen trees being still green, remained under water, allowing two small steamers, the Alert and the Evergreen, to pass freely over them, but now they are dry and will, I think, rise to the surface and float into drifts next winter, completely obstructing navigation for the season, but can perhaps be burned during low-water in the summer of 1882. Hiring two horses and taking with me as guide an experienced raftsman, who was familiar with the country, I rode to the head of One Mile Lake, a distance by creek estimated to be 25 miles. At the head of One Mile Lake the creek becomes very narrow and its bed is filled with very large cypress trees.

The country for 12 miles above is low and swampy, subject to inundations, and is uninhabited. Still higher above are large plantations on the creek banks, but the Yazoo River is near, and roads leading to it are hard and firm even in winter. Considering the above facts, I regard One Mile Lake the head of navigation for Bear Creek.

From Cattlings to One Mile Lake there are three other lakes through which the creek runs, namely, Four Mile Lake, Six Mile Lake, and Three Mile Lake, having lengths of 4, 6, and 3 miles respectively, as indicated by their names, and varying in width from 100 to 1,000 feet, and in depth from 6 to 22 feet.

RÉSUMÉ.

I find Bear Creek to be navigable for steamboats five months in the year, for a distance of 40 miles from its mouth.

It has 22 miles of lakes that require very little improvement, viz:

Wasp Lake, 8 miles long, maximum depth 11 feet, maximum width 200 feet.
Four Mile Lake, 4 miles long, maximum depth 22 feet, maximum width 1,070 feet.
Six Mile Lake, six miles long, maximum depth 18 feet, maximum width 500 feet.
Three Mile Lake, three miles long, maximum depth 12 feet, maximum width 250 feet.
One Mile Lake, one mile long, maximum depth 12 feet, maximum width 200 feet.

This leaves 18 miles of Bear Creek to be improved.

COMMERCIAL STATISTICS.

The following is an estimate of value of shipments during 1880 as obtained from planters on Bear Creek:

Shipped down the creek:

1,000 bales of cotton, worth $50 per bale	$50,000
90,000 oak staves, worth $140 per thousand	12,600
500 tons cotton seed, worth $6 per ton	3,000
400,000 feet lumber, worth $15 per 1,000 feet	6,000
Total	71,600

Shipped up the creek:

Supplies and general merchandise	$800

To give an open channel 75 feet wide and 40 miles long, the following is a list of obstructions to be removed:

Number of trees to be cut	13,572
Number of logs to be taken out of channel	6,786
Number of trees to be girdled	27,144
Number of snags to be removed from channel	150

ESTIMATES.

Cost of working party for one month:

Engineer in charge	$150
Mate or overseer	100
Cook and assistant	60
20 laborers at $40 per month each	800
Subsistence for 24 men, at 50 cents per day each	360
Total	1,470
Building flat-boat	300
Cost of outfit (tools, tents, &c.)	520
Cost of three months' labor and subsistence of laborers	4,410
Contingencies	770
Total estimate	6,000

Very respectfully, your obedient servant,

WALTER S. DAVIS,
Assistant Engineer.

Maj. W. H. H. BENYAURD,
Corps of Engineers, U. S. A.

P 22.

EXAMINATION OF BIG BLACK RIVER, MISSISSIPPI.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., December 10, 1881.

GENERAL: I have the honor to submit the following report of an examination of Big Black River, Mississippi, made, under my direction, by Mr. Walter S. Davis, assistant engineer, in accordance with the provisions of the river and harbor act of March 3, 1881.

This stream rises in Choctaw County, Mississippi, flows in a general southwesterly direction, and empties into the Mississippi at Grand Gulf, having an estimated length of about 400 miles.

I directed the examination to commence at the crossing of the Chicago and New Orleans Railroad, and to be continued to the mouth; a total estimated distance of 226 miles.

The first 96 miles of the portion examined, from the railroad crossing to Cox's Ferry, was found to be so insignificant, and the obstructions to navigation, even at high-water, so great, that no estimate has been made for the improvment of this reach.

From Cox's Ferry to the mouth, a distance of 130 miles, the usual obstructions of snags, logs, and overhanging trees, with several steamboat wrecks, are the impediments to navigation, for the removal of which the estimated cost is $32,000. This estimate contemplates only the clearing of a channel suitable for navigation during the higher stages of water. Sand-bars and elevated gravel-beds are too extensive and numerous to justify a sufficient removal of them to permit the passage of the smallest steamboats during the season of lowest water.

In addition to the obstructions mentioned, there are two railroad bridges across the stream, neither of which is provided with a draw-span. They were built under authority of the State legislature, one by the Vicksburg and Meridian Railroad, the other by the Mississippi Valley and Ship Island Railroad. The first is about 40 miles below Cox's Ferry, and 90 miles above the mouth of the river. As the lower chord of this bridge is only about 7 feet above extreme high-water, and 40 feet above low-water, it offers a complete bar to navigation at this point.

The Mississippi Valley and Ship Island Railroad Bridge crosses at about 15 miles above the mouth. The lower chord, being about 9 feet above extreme high-water and 47 feet above low-water, is a complete stoppage to navigation there.

Reliable statistics of the commerce tributary to the river could not be gathered; but the presumption is that a considerable amount of cotton was carried out by boats during high-water before the Mississippi Valley and Ship Island Railroad Bridge virtually closed the river to the navigation of such small boats as made their way up during high-water.

For a more detailed account of the nature of obstructions, reference may be had to the report of Mr. Davis, herewith.

Very respectfully, your obedient servant,

W. H. H. BENYAURD.
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. WALTER S. DAVIS, ASSISTANT ENGINEER.

MEMPHIS TENN., *October* 1, 1881.

MAJOR: In compliance with your instructions to make an examination of Big Black River, Mississippi, I have the honor to submit the following report:

On the 28th of July, 1881, I commenced at Vaughan's Station, on the Chicago, Saint Louis and New Orleans Railroad, the descent of Big Black River, having previously procured two light skiffs and camp outfit, and having employed two experienced skiffmen and a cook.

Big Black River rises in Choctaw County, and flowing southwest through Choctaw and Montgomery counties, and forming the boundaries in part of Carroll, Attala, Holmes, Yazoo, Hinds, Warren, and Claiborne counties, empties into the Mississippi River a mile above Grand Gulf. Its length is estimated to be 400 miles, and it drains between 2,700 and 2,800 square miles.

For convenience I have divided Big Black River into three divisions or stretches.

FIRST STRETCH

Extends from the source to Way's Bluff, on the Chicago, Saint Louis and New Orleans Railroad mentioned above, a distance, estimated, by river of 180 miles. Down to Vaiden, on the said railroad, the river is only a small, swift creek. From Vaiden to Way's Bluff, a distance of 45 miles by railroad, the river is, in its general course, parallel with the railroad, and in many places they are only half a mile apart.

The country lying along this stretch is gently rolling and well settled. The soil is principally of a hard, grayish, craw-fishy nature, very thin, and in many places filled with soft pebbles, or gravel, of ferruginous formation. There are, however, some rich plantations along the river, a few miles from it. The timber is mostly beech, holly, oak, hickory, and gum.

Owing to the hardness of the soil along the river, its banks are constantly washing or caving and changing its course, causing large trees that grow thick upon the banks to fall into the channel. The current in this stretch is so swift and the bends are so sharp that it is not considered fit for navigation of any description.

SECOND STRETCH

Extends from Way's Bluff to Cox's Ferry in the extreme southern part of Yazoo County, embracing a distance estimated to be 96 miles by river and 35 miles on an air line. Its banks are very low, and like the first stretch constantly caving and causing the river to make new channels.

At Moore's Bluff I found the oscillation of the water of 1881 to be 15.5 feet, while the right bank is only 10 feet high. The greatest depth of water at this point was 7 feet, and the width of river on water surface was 100 feet.

On each side of the river the swamp is very heavily timbered and generally covered with an almost impenetrable wall of cane, vines, &c. Owing to the smallness of the channel and the great volume of water to be discharged in the rainy season, the river overflows the lands lying on each side for 2 and in many places for 3½ miles. While this swamp or overflowed land is very rich alluvial, it is not considered fit for cultivation on account of being under water almost all the winter and early spring. I see no reason why these lands could not be reclaimed by a system of levees along the river banks. During the winter and spring the roads crossing the swamp are almost impassable.

The width of the river at low-water is from 30 to 120 feet, and its depth ranges from 10 inches to 13 feet. Sand shoals covered with not more than 10 inches of water take up about one-half of this stretch, making it exceedingly difficult for us to pass down in our small skiffs.

As the course of the river is very crooked, the current swift, the bends acute, and the channel in many places filled with logs, sand, and willows, it often divides itself into small chutes and cut-offs across bends that would have to be dammed before this part of the river could be made serviceable for navigation. But even then the swiftness of the current, the suddenness of the overflows, and the liability of the channel to change at any time, would prevent the permanency of any improvements that might otherwise be made upon the banks.

The most of the logs in the channel in this stretch lie entirely across the river, with their roots imbedded in the bank on the caving side and their branches covered with sand on the other.

The following table shows more fully the condition of the second stretch. The logs I actually counted; the number of leaning trees was estimated:

Number of logs in channel	2,920
Number of leaning trees	17,000
Number of snags	2,815
Average depth of low-water	4 feet.
Average depth of high-water	17 feet.
Average width of channel in low-water	70 feet.

I do not think the second stretch practicable for navigation, and will therefore pass on to the consideration of the

THIRD STRETCH.

This begins at Cox's Ferry and ends at the mouth of the river. Its estimated length (pilots' measurement) is 130 miles, while the distance on an air line is only 43 miles.

A comparison of these distances shows that the river trebles itself in this stretch; and this is really true, there being a continuous chain of large bends, some of which are 6 miles around and only a few hundred feet across. These bends are less acute than those above Cox's Ferry, and the channel is deeper and wider, the banks higher, the swamp narrower, and more generally cultivated. The bench lands of this stretch, as well as those along the lower part of the second stretch, are very productive and covered with large plantations. Some of these annually produce several hundred bales of cotton, as well as some corn and other grain.

I have been informed by citizens residing near Cox's Ferry that in the years 1875 and 1876, while the Vicksburg and Meridian Railroad bridge was down, three steamboats came up the river as high as this point. Two—the Gray Eagle and the E. G. Good—were steam keel-boats, and the third—the Paxton—was a small side-wheel boat from the coast. These boats came up laden with freight, and, on their return, carried down the river between 500 and 600 bales of cotton, but as the bridge was rebuilt in the summer of 1876, no other steamboats have been seen so high up the river since.

While the distance between the tops of the banks ranged from 200 to 350 feet, the width of the water surface at low-water measured from 40 to 175 feet. Its greatest depth found (except near mouth) was at Bauldwin's Ferry, where it was 18.5 feet. The maximum high-water marks found were at the Vicksburg and Meridian Railroad bridge, and at the Mississippi Valley and Ship Island Railroad bridge. At the former place it was 32.5 feet, and at the latter 38.5. As the river was said to be lower than ever known before, 38.5 feet may be considered the greatest oscillation of Big Black River.

Several miles below Cox's Ferry there are some very steep bluffs, from 100 to 200 feet high, and covered with rock of limestone formation. The largest of these are "Sugar-loaf Bluff," at the point where the line between Yazoo and Warren counties intersect the river, and "Birdsong's Bluff," at Birdsong's old ferry. It is here that a contemplated railroad from Vicksburg to Canton would cross the river. Down to this point the bed and banks of the river are sandy, but from here down to the Vicksburg and Meridian Railroad the bed is generally gravelly, and in many places the current is very swift and channel shallow.

The following table, taken from my field-notes, shows the extent of the gravel beds in this stretch, where the depth is less than 3 feet. Over all these gravel beds I found the current very swift, running at the rate of from 4 to 7 miles per hour. There were a great many logs partly imbedded in the gravel. The small sand shoals are too numerous to attempt to describe.

Name.	Length.	Channel in low-water.		Remarks.
		Depth.	Width.	
	Feet.	*Feet.*	*Feet.*	
No name	200	2	60	Located between Cox's and Messenger's ferries; current very swift; rocky bed with logs.
Do	100	2.3	100	Do.
Do	100	2.5	80	Do.
Do	300	3	100	Do.
Do	300	0.5	120	Do.
Do	300	0.5	110	Do.
Do	100	0.5	90	Do.
Birdsong's Ferry	150	1.5	75	Do.
No name	100	1	120	Do.
Do	790	0.4 to 1	165	Six rocky islands from 100 to 150 feet long and 50 feet wide rise in the middle of channel 3 feet out of water; rocky bed, with logs.
Do	310	0.4 to 1	155	Do.
Do	100	2	130	Do.
Do	100	2	100	Below Messenger's Ferry; rocky bed, with logs.
Do	420	1.5	110	Below Vicksburg and Meridian Railroad and above Bauldwin's Ferry; swift current; rocky bed, with logs.
Do	50	1.5	120	Do.
Do	600	2	120	Do.
Do	150	2	80	Below Fisher's and above Hammer's ferries; current swift; rocky bed, with logs.
Mouth Fourteen-mile Creek	100	2	90	Do.
Mouth Sand Creek	450	2	130	Do.
No name	100	1.5	110	Current swift; sandy bed, full of logs and snags.
Hamer's Ferry	100	1.5	120	Do.
Mouth of creek	600	1	80	Current swift; gravel and clay shoals full of logs and snags.
Do	450	2.5	95	Do.
Hankerson's Ferry	525	2	120	Do.
Mouth of river	500	2.5	350	Current very swift; sand shoal.

Besides the above there is a large flat rock in the middle of channel below Hankerson's Ferry 80 feet long, 45 feet wide, and rising 3.5 feet out of the water.

The river runs in a southerly course to Caker's Ferry, within 1 mile of Edwards' Depot on the Vicksburg and Meridian Railroad, then west 6 miles, then turning south crosses the said railroad. On the left bank of the river at Caker's Ferry is a high hill with the road ascending it that leads to Edwards' Depot. This town contains about 1,000 inhabitants, and shipped last year (I was informed) 16,000 bales of cotton, and does a large plantation-supply business for the surrounding country.

The Vicksburg and Meridian Railroad bridge across the river is a Howe truss bridge, supported by trestling, or six wooden piers, 56 feet apart. It is not a draw-bridge. From top of rail to water measured 43.5 feet, and from bottom of sill to water 39.5 feet. Ordinary high-water rises 20 feet above present water surface, and extreme high-water 32.5 feet, so that there is only a space of from 7 to 21 feet between bottom of bridge and water, too small to allow the smallest steamboats to pass through.

A quarter of a mile above the bridge the river receives a tributary from the north, known as Clear Creek, and makes at this point a bend towards the south, approaching the said railroad and caving away the south bank. For the protection of this bank the railroad company has built five strong wing-dams of post and plank, each several hundred feet long, and about 20 feet high. These wing-dams have only partially stopped the caving, and deepened the channel to 12 feet on the north of them. Immediately below the bridge the wrecks of three large steamboats, that were burned either in 1873 or 1874, are still lying in the channel, only half covered by water. I was told that the largest of these had a carrying capacity of 500 tons.

From the bridge to Bauldwin's Ferry, a distance of about 25 miles, the river is very tortuous; but, with the exception of the shoals mentioned above, it has an average depth of six feet. It receives its largest tributary, Fourteen-Mile Creek, from the left bank, a few miles above the ferry. Cypress lumber is rafted from said creek down Big Black every winter. During the month of August the raftsmen cut into the river most of the overhanging willows for a distance of about 40 miles, and as they were floating on the surface when I passed down, they rendered my progress very slow. How much lumber is annually rafted down the river I could not ascertain. I learned from the ferryman at Bauldwin's Ferry that a small steamboat has been making (up to last winter) two or three trips a year up to this point, each time bringing up merchandise and carrying back cotton, cotton-seed, &c., but he did not know what amounts. It has now left the river. At Wilkins' Ferry (13 miles below) there still remains a small warehouse, where the cotton from several plantations used to be stored for shipment. Here the telegraph wire, connecting Vicksburg and points southeast, crosses the river.

About 15 miles above the mouth of Big Black River is the Mississippi Valley and Ship Island Railroad bridge. It is not a draw-bridge, but a strong iron bridge, and had only a short time been completed when I reached it. It is substantially built on trestle-work, having its main span, of 122.5 feet, supported on two piers situated on opposite banks of the river. The distance between their foundations if 105 feet. The perpendicular distance from top of rail to water was 49.85, and from bottom of lowest sills to water 46.9 feet. I found the high-water mark of 1881 on the trestling, 88.5 feet above low-water. This shows an oscillation of 38.5 feet to be the greatest I found in the river. The greatest depth of water under bridge was 11.4 feet, but the river was, as I have stated above, at its lowest stage. Ordinary high-water is from 20 to 30 feet higher at this point than the present, leaving a space between bridge and water of from 17 to 27 feet, which space is reduced to only 8.4 feet in extreme high-water. Now, as the river is only navigable in high-water, I consider this bridge a bar to navigation for all points above.

With the exception of the shoals described in the foregoing pages, Big Black River has an average depth of 6 feet and an average width of 100 feet in low-water from the Vicksburg and Meridian Railroad bridge to its mouth, while in winter and early spring, or for four or five months in the year, it has an average depth and width of 16 and 150 feet, respectively. In this part of the river, with a tortuous course, it has high sloping banks covered thickly with willows. Being of alluvial or mud deposit formation, these banks do not wash or cave like those of the upper part of the river, but are subject to frequent slides, recurring principally in spring when the water is high. I noticed several places where the entire bank for a depth of 6 or 8 feet and a distance of 50 or 100 feet, had slipped into the middle of the river and remained with all the trees that had grown on it still standing erect. As these slides occur every year and obstruct the channel by implanting firmly into the bed the trees that grow upon the banks, it would be almost useless to improve the channel without clearing or deadening the trees on the banks, that they may decay, for a distance of 75 or 100 feet from the water's edge.

With a view to this, I have made a careful calculation of the number of trees to be cut, as given below.

The following table shows the number of logs and snags in this stretch I have actually counted, as well as the number of trees with an average diameter of 8 inches to be cut and girdled:

Number of trees on bank to be girdled	226,800
Number of leaning trees to be cut	94,500
Number of snags	6,040
Number of logs	7,291

COMMERCIAL STATISTICS.

Owing to the short distances between the Big Black and navigated streams, and between the Big Black and operative and prospective railroads, it would be exceedingly difficult, if not impossible, to state with accuracy what the value of shipment on the river would be if it were improved, or what its commercial advantages, if any at all, would be to the country through which it flows. I learned from old settlers that years ago, long before there were any railroads through this country, there were large quantities of cotton and other articles of produce annually shipped down the river in flat and keel boats, but as such information was rather vague I could not attach much importance to it. The only corroborative evidence I found of this information was the existence of three wrecks of keel-boats I passed lying in the channel in the lower part of Yazoo County.

The following is a statement of distances between Big Black and navigated streams, or between it and railroads, and the distances between proposed and operative railroads crossing the river:

	Miles.
From Satartia, on Yazoo River, to Big Black	8
These rivers run in a parallel course to a point opposite Vicksburg, varying in distance from 7 to 16 miles.	
From Vicksburg down, Big Black and Mississippi River gradually approach each other to Grand Gulf, at no point farther separated than	12
The Mississippi Valley and Ship Island Railroad, on leaving Vicksburg, gradually approaches Big Black until it crosses, 15 miles above the mouth.	
From Big Black to the nearest point on the Jackson and Natchez Railroad	15
As I have already stated, the Chicago, Saint Louis and New Orleans Railroad runs close along the river to Way's Bluff; then leaves it at an angle of about 45°.	
From Way's Bluff to the point where the proposed Canton and Yazoo City road is to cross the river, as per recent survey	12
From same point to Canton	12
From said point to Yazoo City	16
From said point to crossing of the proposed Jackson and Yazoo City Railroad	7
From last-mentioned crossing to proposed Vicksburg and Canton Railroad crossing	20¼
From this crossing to Vicksburg and Meridian Railroad Bridge	9
From Vicksburg and Meridian Railroad Bridge to the Mississippi Valley and Ship Island Railroad Bridge	20¼
From last-named bridge to the mouth of Big Black River	7

These are all air-line distances.

ESTIMATES.

Cost of working party for one month:

Engineer in charge	$150
Mate or overseer	100
Engineer of boat	100
Cook and assistant	60
20 men, at $40 per month each	800
Subsistence of 26 men, at 50 cents per day each	390
Total	1,600

Building light-draught snag-boat	3,500
Snag-boat 16 months in field, at $1,600 per month	25,600
Tools and repairs	500
Contingencies	2,400
Total estimate	32,000

Very respectfully, your obedient servant,

WALTER S. DAVIS,
Assistant Engineer.

Maj. W. H. H. BENYAURD,
Corps of Engineers, U. S. A.

APPENDIX Q.

REMOVING SNAGS, ETC., FROM THE ARKANSAS RIVER—IMPROVEMENT OF ARKANSAS RIVER BETWEEN FORT SMITH AND WICHITA AND AT PINE BLUFF; AND OF RIVERS SAINT FRANCIS, WHITE, L'ANGUILLE, FOURCHE LE FÈVE, SALINE, BLACK, AND CURRENT, IN ARKANSAS AND MISSOURI.

REPORT OF CAPTAIN THOMAS H. HANDBURY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Removing snags &c., from Arkansas River.
2. White and Saint Francis rivers, Arkansas.
3. Arkansas River at Pine Bluff, Arkansas.
4. Arkansas River between Fort Smith, Arkansas, and Wichita, Kansas.
5. White River between Jacksonport and Buffalo Shoals.
6. White River above Buffalo Shoals.
7. L'Anguille River, Arkansas.
8. Fourche La Fève River, Arkansas.
9. Black River, Arkansas.
10. Black River, Arkansas and Missouri.
11. Saline River, Arkansas.
12. Current River, Missouri and Arkansas.

EXAMINATIONS AND SURVEYS.

13. Little Red River, Arkansas.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., July 15, 1882.

GENERAL: I have the honor to transmit herewith my annual reports upon the works of river and harbor improvements under my charge for the fiscal year ending June 30, 1882.

Very respectfully, your obedient servant,

THOS. H. HANDBURY,
Captain, Corps of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

Q 1.

REMOVING SNAGS, WRECKS, ETC., FROM THE ARKANSAS RIVER, ARKANSAS.

The work of removing snags and other obstructions from the navigable channel of the Arkansas River, that at the close of the last fiscal year was suspended on account of the unfavorable stage of the water. was resumed again August 10, 1881. The operations were carried on from the iron snag-boats C. B. Reese and J. R. Meigs, with their officers and crews of hired men, and extended from Fort Smith, Ark., to the mouth of the Arkansas River.

The working season closed this year March 15. During this time the C. B. Reese worked in this river seven months and the J. R. Meigs one, October, making a total of eight months for the two boats.

The following is a summary of the work accomplished during this time: Snags pulled, 976, weighing about 11,000 tons; drift piles removed, 18; trees cut, 3,460.

In obedience to telegraphic instructions from the Chief of Engineers, under date of March 14, 1882, the C. B. Reese, with her officers and crew, were turned over on the 15th to Lieut. Col. Amos Beckwith, Commissary Department, United States Army, for duty under his orders to aid in distributing supplies to the sufferers from overflow of the Mississippi River and its tributaries. The boat was out of my control on this duty until April 15, when it was returned to me at Little Rock, Ark., and laid up in ordinary. The expenses incurred while distributing these supplies were $2,999.47, which amount was paid from the funds appropriated by Congress for this special purpose.

Since the boat has been laid up the usual current repairs have been made and some additional machinery added to her outfit. Heretofore the snags, after being pulled on board, have been sawed up by hand and thrown overboard, a process which consumes much valuable time and adds materially to the expense of their removal. It is now designed to do this work by steam.

The machinery by which it is effected consists of a small engine, 10 horse-power, placed in the hold. This runs a fore-and-aft shaft, extending to the butting-beam. On this are two eccentrics, with friction clutches and suitably arranged arms to give horizontal motion to two saws above deck. One is at the butting-beam, the other 28 feet aft of this.

This same engine is made to run a circular saw, placed in front of the main furnace-doors, where the wood used for making steam can be cut into suitable lengths. It is expected that these additions will materially improve the working capacity of the boat.

The work done during the season had a very beneficial effect upon the navigation of the river and gave general satisfaction to those interested. From the fact that the river, especially in its lower reach, is constantly eroding its banks and changing its channel, many new and troublesome snags are constantly appearing. These come from three principal sources: trees that are at present growing upon the banks, which tumble in when undermined by the erosive action of the water, old trees that have for many years been buried beneath 20 or 30 feet of alluvium, that once lodged in some old channel of the river, and cypress stumps that unexpectedly appear as the river erodes its way into some old buried up cypress swamp.

These old trees are generally found in patches across the present channel. The direction in which they lie indicates that of the old channel of the river. From the frequency of these it is evident that the channel of the river has at some time been over almost every point of its lower valley. On this rich alluvium under which these old trees lie the largest of the present forest trees are sometimes found. The cypress stumps are the most difficult to remove of all these obstructions, and are the most dangerous to navigation.

The washing away of the river banks in one locality and building them up in another seems to have always been going on. While the country was in a state of nature no interest was especially affected by this, but since the advent of civilization in this region this change has always been to the prejudice of its agricultural interests and the detriment of the navigation of the river. Every year many acres of valuable agricultural land are destroyed. The cotton-producing capacity of this has a wide spread reputation, and every year large areas are cleared and devoted to the production of that commodity.

As the erosion of the cultivated land takes place, the bed of the river becomes wider and is more obstructed with islands and sand-bars. For the same amount of water passing down, this depth of channel is diminished and the greater are the difficulties encountered in its navigation.

As the resources of the country through which the Arkansas River flows are developed the greater is the necessity for its improvement in order to insure cheap transportation to market for the products.

This is nature's outlet for the surplus products of a large portion of Western Kansas, Indian Territory, and the State of Arkansas.

The coal interests on the borders of this river in the Indian Territory and Arkansas, which are just now beginning to attract attention, to say nothing of other products, such as cotton, grain, lumber, &c., will soon demand its extensive and permanent improvement.

The removal of snags and other obstructions of like character are of course very beneficial to navigation and very necessary, but under existing circumstances it can afford only temporary relief, which must be continued from year to year until some radical improvement is effected.

The time has now come when it would be advisable to take in hand the subject of the permanent improvement of the Arkansas River thoughout its navigable extent from Wichita, Kans., to its mouth.

To give the subject the thorough and comprehensive study that its importance demands there should be an accurate survey and map made of the whole extent of the river between these limits, and all possible data bearing upon the subject should be collected. This is a first and absolutely necessary preliminary. Such a survey has already been made of that portion of the river between Little Rock, Ark., and Fort Gibson, Indian Territory, near the mouth of the Grand River. This was done in 1869, under the direction of Col. J. N. Macomb, Corps of Engineers, U. S. A. There yet remains to be surveyed that portion of river lying above the mouth of the Grand River, Indian Territory, and the portion lying below Little Rock, Ark. In my annual report of last year the subject of these surveys is alluded to, and estimates of the cost of making them submitted.

The estimate of $21,000 for making the survey of the Arkansas River between its mouth and Little Rock, Ark., is again renewed.

ESTIMATE FOR THE FISCAL YEAR ENDING JUNE 30, 1884.

Working expenses of snag-boats, including current repairs, twelve months, at $3,000 per month, $36,000. For continuing the survey of the Arkansas River from Little Rock, Ark., to its mouth, $21,000.

This work is in the collection district of New Orleans. The nearest port of delivery is Memphis, Tenn.

Money statement.

July 1, 1881, amount available	$30,[illegible]6 37
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	26,479 96
July 1, 1882, amount available	4,356 41
Amount appropriated by act passed August 2, 1882	35,000 00
Amount available for fiscal year ending June 30, 1883	39,356 41
Amount that can be profitably expended in fiscal year ending June 30, 1884	57,000 00

Q 2.

IMPROVEMENT OF WHITE AND SAINT FRANCIS RIVERS, ARKANSAS.

The work of improving these two rivers during last year was confined to the removal of snags, logs, overhanging trees, and other like obstructions to their navigation.

On the White River operations were carried on from the iron-hulled snag-boat J. R. Meigs, with her crew of officers and men. They extended from the mouth of the river as high up as Newport, Ark. This boat was turned over to me by Major Benyaurd, Corps of Engineers, on the 23d of August, and on the 28th work was commenced at the mouth of the White River. This was continued until the end of September. During this time 279 snags were pulled, 2 drift-piles removed, 2 sunken barges destroyed, and 122 trees cut.

During the month of October the boat was assigned to duty in the Arkansas River. On the 5th of November she was laid up in ordinary at Newport, Ark.

The amount available for work upon these two rivers during the year was so exceedingly limited, that where a due proportion was reserved for the Saint Francis River, and the amount necessary for the care of the boat in ordinary, a longer time than this could not be devoted to work; a fact which is very much to be regretted, since the river was in excellent condition for work, and a much-needed improvement in the navigation of the river could have been made had the funds necessary been available.

On the Saint Francis River an outfit consisting of a decked scow, provided with steam hoisting power, rope, tackle, &c., quarters and mess outfit, and a party of men, were hired. This was found to be a much more economical method of removing obstructions from this river than by employing so large a boat as the Meigs. In fact, this boat cannot navigate this stream unless it be at a medium or higher stage of water. At such times the troublesome low-water snags are not visible, and consequently cannot be removed. It is only at extreme low-water and with such an outfit as above described that useful work can be done in this stream.

On the 1st of November work was commenced near the mouth of the river, and at the end of December the party was discharged. The operations of the party extended as high up as Wittsburgh.

Between the mouth of the river and Madison, the point where the Memphis and Little Rock Railway crosses, 106 snags, 1 sunken raft, and 14 logs were removed from the channel, and between Madison and Wittsburgh 243 snags, making a total of 349 snags—troublesome snags—that were removed. In view of the fact that these two rivers are entirely dissimilar in character, and that the plant which would be suitable for economical work in one would not be adapted to the other, it is suggested that a separate appropriation be hereafter made for each.

The snag-boat J. R. Meigs can be worked to very good advantage in the White River for about six months during the year, but last season's experience on the Saint Francis River shows clearly, I think, that a strongly built decked scow, drawing not more than 10 or 12 inches of water, properly supplied with suitable appliances for removing obstructions to navigation, and with accommodations for the working party, can be worked to very great advantage.

Such an outfit would cost about $4,000. Its running expenses would be about $1,500 per month, and it could be worked to advantage for about eight months in the year.

ESTIMATE FOR THE FISCAL YEAR ENDING JUNE 30, 1884.

White River, below Jacksonport, Ark.:		
Working expenses of snag-boats, including incidental repairs, six months, at $3,000 per month		$18,000
Expenses in ordinary and general repairs		2,000
		20,000
Saint Francis River, Arkansas:		
Outfit	$4,000	
Working expenses of same eight months, at $1,500 per month	12,000	
		16,000
		36,000

The work is situated in the collection district of New Orleans. The nearest port of delivery is Memphis, Tenn.

Total amount appropriated, $142,000.

Money statement.

July 1, 1881, amount available	$8,178 07
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	7,672 43
July 1, 1882, amount available	505 64
Amount appropriated by act passed August 2, 1882	12,000 00
Amount available for fiscal year ending June 30, 1883	12,505 64
Amount that can be profitably expended in fiscal year ending June 30, 1884	36,000 00

Q 3.

IMPROVEMENT OF ARKANSAS RIVER AT PINE BLUFF, ARKANSAS.

During this season 3,000 feet of low-water revetment was added to the bank protection of Yell's Bend, 2 miles above Pine Bluff, thus making the total length of revetment in this bend 6,700 feet. It was contemplated that when this was extended about 2,000 feet further down it would be sufficient to protect the upper side of the narrow neck at this place, which is in danger of being cut through by the erosion of the river. The dike, which was built below, and described in my report of last year, with the view of throwing the water to the right bank and rectifying the channel, was partially washed away at the first rise, which was a sudden and consequently unfavorable one for this class of structure. It was repaired, however, and is now satisfactorily accomplishing the object for which it was built.

Throughout this 3,000 feet of bank, the foot of which was protected to the surface of the water at the time the revetment was put in place, the grading for the high-water protection was also done. When about 700 feet of the high-water protection was in place a sudden rise in the river caused a suspension of operations, and washed in behind the graded bank, causing considerable damage to the low-water protection. For want of funds, these repairs are necessarily postponed until such a time as further appropriations become available. The revetment was of the same materials and made in the same manner as that made last season. The grading was done by hydraulic power. An 18½ by 10¼ by 10 inch Worthington pump, throwing from 600 to 800 gallons per minute, was employed for this purpose. It was placed upon a small stern-wheel boat, the boilers of which furnished the steam-power. The water was conveyed from the pump to the bank through, first, 10 feet of 6-inch rubber hose, then 50 feet of 6 inch gas-pipe, at the end of which was a wye with 4-inch branches, to each of which was connected 50 feet of 4-inch rubber hose, with nozzles on the outer ends. The 6 inch gas-pipe was used as the boom of the derrick, which could be swung through a sufficient angle to allow considerable extent of bank to be reached without moving the boat. The arrangement worked admirably, and the grading was done at a great reduction of cost over what is called the hand process. The hydraulic grading cost, approximately, 2 cents per cubic yard.

The material graded was sand and loam, with an occasional stratum of tough, hard clay, known locally as gumbo or buckshot. This last substance adds greatly to the expense of the grading.

With the funds that may next become available it is proposed, in continuation of the general plan approved, to repair the damage done to the revetment already in place, and extend it down from 1,500 to 2,000 feet farther than it now is. Then commence the revetment of the lower side of the narrow neck, and put in such permeable dikes for the rectification of the channel as may be found advisable, carrying these works on as far as the amount of the funds will admit.

This work is in the collection district of New Orleans. The nearest port of entry is Memphis, Tenn.

Total amount appropriated from the commencement of the work, $48,000.

Money statement.

July 1, 1881, amount available	$23,988 04
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	22,179 03
July 1, 1882, amount available	1,809 01
Amount appropriated by act passed August 2, 1882	20,000 00
Amount available for fiscal year ending June 30, 1883	21,809 01
Amount that can be profitably expended in fiscal year ending June 30, 1884	32,000 00

Q 4.

IMPROVEMENT OF THE ARKANSAS RIVER BETWEEN FORT SMITH, ARKANSAS, AND WICHITA, KANSAS.

Work under this appropriation during the year was confined to the operations of the snag-boat Wichita, which was under process of construction and nearly finished at the end of last season. This boat is designed especially for work upon this reach of the Arkansas. It is 125 feet long, 26 feet wide, 3 feet depth of hold, and draws 15 inches. It has accommodations for a crew of twenty-five officers and men, with their outfit and supplies.

The boat is propelled by two engines, 8½ inches in diameter, 3 feet stroke, supplied with steam from two steam boilers 36 inches diameter, 16 feet long, with four lap-welled flues in each, two 8 inches, and two 10 inches. The hoisting power is supplied by a steam capstan, with double reversible engines 6 by 12 inches. The spindle is steel, 5 inches diameter. This power is applied through a crane capable of lifting between 40 and 50 tons. The outfit of rope, tackle, saws, axes, &c., is complete. In every way the boat seems well adapted to her work.

On the 28th of September, 1881, the boat was finished, and left Little Rock for the field of its operations.

The design was that it should proceed as rapidly as practicable to Arkansas City, Kans., doing only such work as was necessary to effect its own passage, and when that point was reached it was to turn back and remove such obstructions as would be necessary in order to insure a navigable channel. No difficulty was experienced in carrying out this programme until the boat reached the mouth of the Verdigris River, which empties into the Arkansas about 100 miles above Fort Smith. Above this point the character of the river entirely changed. The channels were very crooked and obstructed with numerous sand-reefs. In the bed of the river were many islands, tow-heads, and sand-bars that divided the waters and prevented any one well-defined channel being formed.

Whilst there was plenty of water to have given a good channel 3 feet deep and 300 feet wide, had it all been concentrated, it was with difficulty that one was found to float the boat, then drawing about 16 inches.

With great effort, and many delays on account of these difficulties, the boat succeeded, on the 21st of November, in reaching the Pawnee Agency Landing. This point is estimated to be about 270 miles above Fort Smith and 75 miles below Arkansas City.

After some delay at this place, instructions were sent to the captain of the boat to the effect that if he could not get up the river farther, he was authorized to withdraw from this upper reach of the river and confine his operations for the balance of the season to the reach between Fort Smith, Arkansas, and the mouth of the Grand River, in Indian Territory, or, if he could not do either, to discharge the greater portion of his crew and keep only a sufficient number of men to guard the boat and bring it down the river in case a sudden rise should occur. Until the 26th of February the boat lay at this place, being unable to get either up or down. A slight rise having taken place on the following day, it started down the river and succeeded in getting about 90 miles and near the mouth of the Cimarron River. Here there was another delay for want of water until May 5, 1882. On the 9th of May the boat reached the mouth of the Grand River, having been absent from this point just seven months.

Since this time active operations have been in progress between the mouth of Grand River and Fort Smith, Ark.

Although these eleven months were not fruitful of much work accomplished for the benefit of navigation, the experience was valuable in one respect. It demonstrated the absolute necessity for concentrating the water that is running over the bottom of this reach of the river, in many small channels or rivulets, into some one which shall carry it all, if it is ever to be made available for navigable purposes. The water in this portion of the river is said to have been exceptionally low during all those months, yet there is no doubt but that if it had been concentrated into a single channel of 200 or 300 feet width, there would have been a depth of from 2½ to 3 feet. The greater portion of the river throughout this reach flows over an exceptionably wide bottom, which is cut up, as before mentioned, by numerous islands and sand-bars.

To enter upon the work of concentration without first having made an accurate map of the river from an instrumental survey, and thoroughly studied all the conditions of the problem, would be injudicious, and might probably result in great waste of the public money.

That the improvement of the river is feasible, and within reasonable limits of expense, there can be no doubt, and that it would be of inestimable value to a large section of country rich both in mineral and agricultural products there can also be no doubt.

It is to be hoped that funds can, at an early day, be made available for the prosecution of this survey. In the mean time the plan of improvement already approved, which is the removal of snags, rocks, and other obstructions to navigation, can be carried forward as far as funds made available will suffice, in those portions of the river where concentration is not an absolute necessity.

During the month of June some slight repairs were made to the dike at Fort Smith, Ark., by the addition of 440 brush mattresses 16 by 4 by 1 foot and 80 tons of stone.

This work is in the collection district of New Orleans. The nearest port of delivery is Memphis, Tenn.

Total amount of appropriations, $59,000.

Money statement.

July 1, 1881, amount available	$30,074 74
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	21,451 90
July 1, 1882, amount available	8,622 84
Amount appropriated by act passed August 2, 1882	20,000 00
Amount available for fiscal year ending June 30, 1883	28,622 84
Amount that can be profitably expended in fiscal year ending June 30, 1884	30,000 00

Q 5.

IMPROVEMENT OF WHITE RIVER BETWEEN JACKSONPORT AND BUFFALO SHOALS, ARKANSAS.

In consequence of the very limited amount of funds available for this work at the commencement of the year, and of the great importance of improving that portion of the river between Jacksonport and Batesville, where the more important part of the commerce was carried on, it was determined to expend the whole upon this reach of the river. The work was done by two parties; one to build brush and gravel dams for the temporary improvement of some of the most troublesome shoals; the other to remove snags, logs, overhanging trees, and other obstructions of a like character. The work was under the direction of Assistant J. D. McKown.

At the commencement of the year the shoal party was at work at

Maguire's Shoal extending the brush and gravel dam in process of construction at that place. A length of about 200 feet was added. The old dam was also slightly raised.

Upon the completion of this the party was moved about 9 miles up the river to Saffold Shoals, where there was a piece of river very troublesome to navigation, where boats were frequently delayed from ten to twenty hours. The difficulty was a wide river-bed, with sand-bars and no well-defined channel. To improve this a dam was built from the left bank of the river 2½ feet high and 500 feet in length, joining the upper end of a middle bar; this effectually prevented the water wasting behind the bar. From the foot of the bar another low dam extended down stream 750 feet, preventing the water wasting over in that direction, thus concentrating the whole along the right shore. The effect of this was very satisfactory. A navigable depth of 4½ feet was obtained where but 16 or 17 inches could be found before the work was commenced.

The next place improved by the party was Haggletooth Shoal, about 6 miles above Jacksonport, another very troublesome piece of river. The difficulty here was of the same nature as at the other points where improvement had been effected. The bed of the river being wide, and the water cut up with sand-bars, no well-defined channel was formed.

The remedy was, as before, to concentrate the water into one channel. This was done and relief quickly followed. Boats passed with no trouble where formerly they were delayed from ten to twenty-four hours with light loads.

The locations of these dams and their effects can best be studied from the sketches which accompany this report.

The snagging party during the season did very effective work, especially when we consider its number and the cost of its outfit. It consisted of from ten to twelve men. The outfit was a strong scow, provided with a crab, blocks, tackle, rope, saws, axes, &c. On the scow was a cabin which furnished quarters for the men. During the season 590 snags and 36 stumps were taken from the channel, and 337 trees were cut from the banks.

These improvements, although quite successful for the time being, can be regarded only as temporary. It is expected that in the course of time these dams will wash away and new troublesome snags will take the place of the old ones removed. There will be a constant necessity for the renewal of such work until such time as a permanent and radical improvement of the entire river can be effected. The country along the borders of this river, which is entirely dependent upon it and the ordinary country roads for lines of transportation of its surplus products and return merchandise, is being rapidly developed. In the course of a very few years the needs of its commerce will require that the river be radically improved by some system of permanent works, extending throughout its whole navigable extent. As yet there has been no instrumental survey made of this river of sufficient accuracy to be used as a basis for plans for such improvements as are necessary. The most that has been done in this direction is the result of hasty reconnaissances, and one or two surveys of isolated localities made for special purposes.

In view of the necessity which must soon arise for a more permanent improvement of this river, it is suggested that steps be at once taken to collect the data necessary for an intelligent and comprehensive solution of the problem. The first and most important requisite is an accurate map, made from a careful instrumental survey, which will show all the features of the river and the country on its borders. All data bearing upon the problem should be collected and carefully studied before any plan of improvement is adopted. The improvement should comprehend all that portion of the river between its mouth and head of navigation, or the point that can be made the head, within reasonable limits of expense. This distance is estimated to be about 600 miles. The cost of a survey, such as is desired, including making maps, collecting data, &c., would be about $80 per mile, or say $50,000 for the whole distance. Of this amount $25,000 could be profitably expended in one season.

ESTIMATE FOR FISCAL YEAR ENDING JUNE 30, 1884.

Continuing work according to present plan of improvement, improving shoals, removing snags, &c	$20,000
Survey of White River from Forsyth, Mo., to its mouth	25,000

This work is in the collection district of New Orleans. The nearest port of delivery is Memphis, Tenn.

Money statement.

July 1, 1881, amount available	$7,480 31
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	5,214 63
July 1, 1882, amount available	2,265 68
Amount appropriated by act passed August 2, 1882	6,000 00
Amount available for fiscal year ending June 30, 1883	8,265 68
Amount that can be profitably expended in fiscal year ending June 30, 1884	45,000 00

Q 6.

IMPROVEMENT OF WHITE RIVER ABOVE BUFFALO SHOALS, ARKANSAS.

This work, as far as the navigation of the river is concerned, may be considered an extension of that carried on between Jacksonport and Buffalo Shoals.

The obstructions to navigation, however, are of a different character. Here reefs of rocks and loose bowlders form the principal obstructions to be removed, while in the lower reaches of the river they are sand and gravel bars, with logs and snags.

The operations of the season were confined to a reach of the river about 15 miles in extent above Buffalo Shoals. In this reach three very bad shoals—Crooked Creek, Red Bud, and Summer—were improved and rendered navigable, at a stage of water 3 feet less than that heretofore. In fact, there is from a foot to 18 inches better water over these shoals now than there is over Buffalo Shoals below.

After these improvements were made the Upper White River steamers made several successful trips above Buffalo on medium high stages of water. This could not have been done before.

The report of Assistant J. D. McKown, who has been in charge of this work during the season, together with the sketches herewith, will explain more in detail the operations carried on.

With the funds that are available for operations during the fiscal year ending June 30, 1883, it is proposed to remove the obstructions at Buffalo Shoals, so as to get the same depth of water there as above, and to carry the improvement on up the river on the general plan adopted as far as the amount will admit.

The work is situated in the collection district of New Orleans, and the nearest port of delivery is Memphis, Tenn.

Total amount of appropriation, $20,000.

Money statement.

July 1, 1881, amount available	$19,708 33
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	18,055 49
July 1, 1882, amount available	1,652 84
Amount appropriated by act passed August 2, 1882	4,000 00
Amount available for fiscal year ending June 30, 1883	5,652 84
Amount that can be profitably expended in fiscal year ending June 30, 1884	12,000 00

REPORT OF MR. J. D. M'KOWN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., February 28, 1882.

CAPTAIN: I have the honor to submit the following report of work done during the season of 1881–'82 on White River above Buffalo Shoals, Ark., with the accompanying maps:

CROOKED CREEK SHOAL.

This shoal is situated about 5 miles above Buffalo Shoals, and is, or rather was, one of the worst and most dangerous places on the river. The bed of the stream is of rock, rising in some places at least 3 feet above low-water surface, and so close together as to prevent the passage of boats unless the water was high enough to pass over them. Another difficulty was the width of the river in places, causing the water to spread over too great a surface.

The method of improvement adopted was to blast out the rock from the channel and use the material obtained, where practicable, to build dams and dikes in order to concentrate the water. At this shoal four dams were constructed. No. 1, at the lower end of the shoal proper, is a spur-dam built out from the left bank 185 feet, with a face of 3½ feet, crown 4 feet, base 15 feet, and contains 228 cubic yards.

Dam No. 2 extends from the left shore, is 160 feet long, face 4 feet at the bank and 2 feet at the outer end; crown, 5 feet; base, 12 feet; contents, 151 cubic yards. This dam is out of water at a low stage, but concentrates the water when there is a slight rise. The rock used was blasted out of the channel in the vicinity of the dam.

Dam No. 3 also extends from the left bank, is 350 feet long, with face 4½ feet, crown 6 feet, base 20 feet, and contains 583 cubic yards of rock. There is a training wall running downstream 325 feet, with a slight angle to the left, with a face of 3 feet, crown 3 feet, and base 10 feet, containing 235 cubic yards.

Dam No. 4 is at the head of the shoal, and extends from the left bank to the head of the island. It is 325 feet long, has a face of 40 inches, crown 8 feet, and base of 25 feet. The contents are 1,003½ cubic yards. A training wall runs from the end of the dam downstream and along the right bank of the island 450 feet, with a face of 30 inches, crown 4 feet, and base 12 feet. The contents of the training wall are 333 cubic yards. All the rock used in the dams on Crooked Creek Shoal was taken out of the channel, most of it by blasting.

The beneficial effects of the improvement at this shoal are very marked. Boats can now pass on at almost 3 feet less water than formerly, while the danger has been reduced very much, as the bed of the stream is comparatively smooth. The banks were trimmed of all timber that would be liable to interfere with the passage of boats at any stage of water.

RED BUD SHOAL.

At Red Bud Shoal but one dam was constructed. This extends from the right bank to the head of the island. Part of the rock was taken from the river, but most of it from the bluff immediately opposite, the object of the dam being to throw all the water between the left bank and the island. The dimensions of this dam are: length, 268 feet; face, 4½ feet; crown, 10 feet, and base, 30 feet; contents, 882 cubic yards. There were three ledges in the main channel, one of which (the lower one) was all taken out, but the unusual occurrence of a rise in the river during the months of October and November very seriously interfered with the progress of the work. However, enough of the others was taken out to give a very good channel for the boats, and has been a very great help to navigation.

The timber was also cut from the banks at this shoal.

SUMMER'S SHOAL.

At Summer's Shoal the improvement consisted in taking out the loose rock which caused the shoal, and throwing out a dam from the right bank beyond the head of the island so as to force all the water into the main channel, as about one half of it passed to the right of the island. A training wall was projected to run down from the outer end of the dam and join the island, as shown by the dotted line on the map, but the high-water also interfered with the work here, although some rock taken from the channel was roughly thrown in place.

This dam is 450 feet long, with a face of 4 feet, crown 10 feet, and base 35 feet. It is built partly on heavy gravel and partly on rock, but has a foundation of brush and rock where resting on the gravel. Most of the material was hauled from the bluff on the left bank of the river.

The dam is a very substantial piece of work, and I think will answer the purpose for which it was intended. It contains 1,500 cubic yards of rock. The accompanying tracings will show the position of the dams and location of the ledges taken out.

The total number of trees cut from the banks from the foot of Crooked Creek Shoal to Wildcat Shoal, 3 miles above Summer's Shoal, was 3,860, all over 6 inches through. This timber was cut into lengths of 12 and 20 feet so that they would float off during the high-water, and being short enough to prevent their becoming troublesome if lodged.

The explosive used on the work was dynamite, No. 2, used with platinum fuses and fired by a magneto-electric machine. With proper precautions, which are very simple, the dynamite is much safer than black powder, and far more effective, especially in wet blasting.

White River, in this locality, is the only outlet for the country adjacent to it, the alternative being to transport the produce by wagon to the nearest railroad, the distance in some places being 100 miles.

Cotton is the main product. A statement of the amount raised can be found in the Report of the Chief of Engineers for 1880, pages 1312–13.

I wish to make favorable mention of Mr. J. T. Dorey, who gave me very able assistance throughout the working season.

Very respectfully, your obedient servant,

J. D. McKown,
Assistant Engineer.

Capt. Thos. H. Handbury,
Corps of Engineers, U. S. A.

Q 7.

IMPROVEMENT OF L'ANGUILLE RIVER, ARKANSAS.

Work on this stream during the year was confined to one month's operations of the small party and outfit that was engaged upon the Saint Francis.

The party ascended as far as Marianna and removed all the snags and overhanging trees that were obstructions to navigation at that stage of the water. The demands of the commerce on the stream did not seem to require further expenditure from the small balance available for this work. It is proposed to expend the amount yet remaining of the appropriation for this work in removing snags, overhanging trees, &c., as occasion may require.

Total amount of appropriation	$17,000

This work is in the collection district of New Orleans, and the nearest port of delivery is Memphis, Tenn.

Money statement.

July 1, 1881, amount available	$4,651 13
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	1,502 26
July 1, 1882, amount available	3,148 87

Q 8.

IMPROVEMENT OF FOURCHE LA FÈVE RIVER, ARKANSAS.

The work of the improvement of this stream extended from its mouth to Harrison Shoal, a distance of 60 miles. It was commenced August 15, and carried on until the end of October. A small steamer was hired, and supplied with the necessary outfit and a party of men to do the work. The water was extremely low, and considerable difficulty was experienced in moving the steamer from place to place where work was required to be done. Temporary dams had to be built in order to float the boat over the shoals which separated the pools, and so small was the amount of water then running in the bed of the stream that sometimes it would take days to fill these dams.

During the season 293 snags and 183 logs were removed, and 685 overhanging trees cut down.

This stream during a greater portion of the year is navigable from its mouth up to Perryville, 40 miles, and its commerce justifies the expenditures that have been made for its improvement. Above that point, however, it is extremely doubtful whether any advantage can be gained by attempting its improvement that would in the least compensate for the outlay that would be required.

The valley of the stream is very fertile, and is being rapidly settled by an industrious, hard-working class of immigrants.

Above 1,000 bales of cotton and 20,000 packages of other commodities were transported on this stream during last season.

The work is situated in the collection district of New Orleans, and the nearest port of delivery is Memphis, Tenn.

Total amount appropriated, $17,000.

Money statement.

July 1, 1881, amount available	$3,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	2,898 15
July 1, 1882, amount available	101 85
Amount appropriated by act passed August 2, 1882	4,000 00
Amount available for fiscal year ending June 30, 1883	4,101 85
Amount that can be profitably expended in fiscal year ending June 30, 1884..	10,000 00

Q 9.

IMPROVEMENT OF BLACK RIVER, ARKANSAS.

The improvement on that part of the Black River within the limits of the State of Arkansas consisted in removing snags, logs, and overhanging trees that obstructed its navigation.

A small steamer was hired, and with a suitable outfit and party work was commenced on the 1st of August. Operations were continued until October 1, at which date the outfit was transferred to the Current River. The reach of the river over which operations were carried on extended from its mouth to the mouth of the Current River, a distance of about 160 miles. During the season 388 snags were destroyed, 1,100 leaning trees were felled, and 157 trees deadened.

In consequence of the limited balance of the appropriation available, no attempt was made to further improve any of the shoals, or to carry the work above the mouth of the Current River. The small balance which is yet remaining of the appropriation of June 14, 1880, will be expended in the prosecution of the general project approved for the improvement of this river within the State of Arkansas.

Money statement.

July 1, 1881, amount available	$5,104 01
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	4,293 35
July 1, 1882, amount available	810 66

Q 10.

IMPROVEMENT OF BLACK RIVER, ARKANSAS AND MISSOURI.

By the act of Congress approved March 3, 1881, the amount appropriated for this improvement was "to be applied from Poplar Bluff." To comply with this provision of the law, operations were commenced at Poplar Bluff and carried downstream as far as the funds available would allow.

The working party was supplied with an outfit consisting of two flatboats. One, 46 feet long, 14 feet wide, 2 feet deep, strongly built and decked, was provided with two Providence power-capstans, and other ordinary tools and appliances, such as are used for removing snags, trees, &c., from these small southern streams. The other was the quarter-boat for the men, 60 feet long, 16 feet wide, and 3 feet deep. On this was a kitchen and quarters sufficient to accommodate about 25 men.

Ten miles below Poplar Bluff the river divides into two channels. The left-hand one, with reduced width, but increased slope, carries the greater portion of water. This is known as the "Chute." The right-hand channel, and probably the original bed, forms what is called "Dan River." It carries about 25 per centum of the entire volume of the stream, and is completely filled with snags, logs, and *débris*. It rejoins the Chute about 20 miles below its head. The water entered this channel in four inlets. The project for improvement contemplated closing these and removing the obstructions from the Chute. While the boats were being built at Poplar Bluff, dams were put in at the head of Dan River. They were composed of alternate layers of loose brush and earth. These layers of brush were placed with their butts downstream, the course farthest down being first laid and the next shingled over it. The dams were made very broad at the base, and carried up about 2 feet above water.

The snagging operations were commenced about the middle of October and carried on until the end of December. During this time 20 miles of river were gone over, 583 snags were destroyed, and about 2,000 trees of various sizes that obstructed navigation were removed.

Although this distance is very short the improvement has been of great advantage to the navigation of the river. From the forests that border on this river there are yearly large quantities of staves and other lumber shipped from Poplar Bluff to the Saint Louis market. It is this trade which the improvement at present particularly benefits.

From Poplar Bluff to the mouth of the Current River it is estimated to be about 146 miles. There yet remains 126 miles from which the snags and overhanging trees are to be removed, besides one railroad bridge, before the river can be said to be in a condition that will admit of boats passing from Poplar Bluff to its mouth. It is not a question of water—there is plenty of that; it is only one of removing snags, overhanging trees, and improving a few shoals.

In this connection I would renew the suggestions contained in my annual report for last year, relative to the improvement of this river. These may be found in the printed Report of the Chief of Engineers for 1881, page 1516.

The following is the estimate of the amount that could be profitably expended upon the Black River in Arkansas and Missouri during the fiscal year ending June 30, 1884:

1 light-draught boat and outfit	$15,000
Expenses of same, seven months, at $2,000 per month	14,000
Repairs and care in ordinary	1,000
	30,000

This work is in the collection district of New Orleans, and the nearest port of delivery is Memphis, Tenn.

Total amount of appropriations for Black River in Arkansas and Missouri, $21,000.

Money statement.

July 1, 1881, amount available	$6,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	5,140 75
July 1, 1882, amount available	859 25
Amount appropriated by act passed August 2, 1882	10,000 00
Amount available for fiscal year ending June 30, 1883	10,859 25
Amount that can be profitably expended in fiscal year ending June 30, 1884.	30,000 00

Q 11.

IMPROVEMENT OF SALINE RIVER, ARKANSAS.

The work of the season upon this stream extended from Cavaness Landing to Longview, a distance of about 50 miles. Some little work was also done above Cavaness. In this distance the following obstructions to navigation were removed, viz: 5,633 overhanging trees, 1,300 logs, and 446 snags and stumps. Two hundred and thirty-six trees were girdled.

The total distance that has thus far been worked over, from Big Island to Longview, is about 180 miles. The distance yet remaining to the mouth of the river is 70 miles.

The work done seems to give great satisfaction to the steamboat men, who are interested in its prosecution. Boats make the trip from Trenton, La., to Mount Elba and return in about the same time that it formerly took them to go to Longview and return. It is certainly a great benefit to those living in the valley of the river.

The average produce shipped out by this river each year is about 10,000 bales of cotton, 50,000 staves, 200 bales of hides and sundries, besides other commodities.

It is proposed to expend the funds that may become available for the present fiscal year as well as those yet remaining from the appropriation for the last year in improving the river from Longview to its mouth.

Total amount of appropriations	$12,500
Original estimate for improving this river	30,151

The work is in the collection district of New Orleans, and the nearest port of delivery is Memphis, Tenn.

Money statement.

July 1, 1881, amount available	$8,637 26
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	6,162 94
July 1, 1882, amount available	2,474 32
Amount appropriated by act passed August 2, 1882	4,000 00
Amount available for fiscal year ending June 30, 1883	6,474 32
Amount that can be profitably expended in fiscal year ending June 30, 1884	10,000 00

Q 12.

IMPROVEMENT OF CURRENT RIVER, MISSOURI AND ARKANSAS.

On the 1st of October the chartered steamer John H. Williams, with a party of laborers, entered this stream and proceeded to remove the snags and clear away the overhanging trees that obstructed its navigation. These operations were carried on until the end of the month, when the party was withdrawn. The work extended as high up as Black River Cut-off, and for this distance was a material improvement to the navigation of the stream. On account of the very small amount of funds made available for this improvement, a very short reach at the river could be gone over.

One hundred and eighty snags were removed and about 3,000 overhanging trees cut down.

With the balance yet remaining and any further amounts that may be made available for this stream, it is proposed to continue the work of removing snags and overhanging trees.

The work is in the collection district of New Orleans, and the nearest port of delivery is Memphis, Tenn.

Total amount appropriated, $7,000.

Money statement.

July 1, 1881, amount available	$2,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	1,465 17
July 1, 1882, amount available	534 83
Amount that can be profitably expended in fiscal year ending June 30, 1884	10,000 00

Q 13.

EXAMINATION OF LITTLE RED RIVER IN ARKANSAS.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., December 8, 1881.

GENERAL: The examination of the Little Red River, Arkansas, with a view to improving its condition for navigable purposes, provided for in section 3 of the river and harbor act approved March 3, 1881, was assigned to my charge by letter of the Engineer Department dated March 21, 1881.

This examination has been made, and the results I now have the honor to report.

The Little Red River is a small stream that rises in the western portion of Van Buren County, Arkansas. Its course is in an easterly direction through said county, and southeast through White County to its junction with the White River, about 20 miles below Augusta, Ark. The stream is of no importance whatever in a navigable point of view until we reach the vicinity of the town of Searcy, situated 2 miles west of its right bank, and about 48 miles from its mouth. Steamboats have on one or two occasions during very high stages of water ascended for this distance.

As a general thing the stream cannot be said to be navigable above the town of Judsonia, 39 miles from its junction with the White River. In considering the present improvement of this stream, all above this point may very properly be omitted, for the reason that no improvement in its navigable qualities could be made without resort to some species of slackwater structures, the expense of which would exceed the total value of all the commerce that would be transported over it for many years. Even this would not insure continual navigation, as the bed of the stream is not unfrequently capable of being crossed dry shod.

From Judsonia down it is possible, within justifiable limits of expense, to put the stream in a condition to be navigated for from seven to eight months during the year; and to West Point, 30 miles from its mouth, it can, perhaps, be made navigable throughout the entire year. The backwater from the White River at its ordinary stage extends to this point, and during its high water to Judsonia?

The principal obstructions to the navigation of this part of the stream are snags and overhanging trees at intervals throughout the entire distance, a sand-bar below West Point, and a shoal (Utley's) between West Point and Judsonia.

It is estimated that $16,100 will be required to remove these obstructions and place the river in a condition which will suffice for the present needs of its commerce.

For more detailed results of this examination, and for such statistical information as we have been able to collect, I respectfully refer to the report of Assistant F. W. Tuttle, herewith inclosed.

Very respectfully, your obedient servant,

THOS. H. HANDBURY,
Captain, Corps of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. F. W. TUTTLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., December 6, 1881.

CAPTAIN: I have the honor to submit the following report on my examination of the Little Red River, Arkansas:

The examination was made October 18-22, 1881, in compliance with instructions contained in your letter dated October 4, 1881, and covered that portion of the river included between Searcy Landing and its junction with the White, a distance of 48 miles. Its objects were the collection of data in regard to obstructions to its navigation and of statistical information bearing upon contemplated improvements.

By a reference to the accompanying sketch, a general idea of the topography of this section of the country can be obtained. The only towns on the stream are Searcy, Judsonia, and West Point.

Searcy, 2 miles from the river and 48 miles from its mouth, is a growing town of 1,400 inhabitants. It shipped last season 9,800 bales of cotton, together with green and dry hides and wool on which figures were not obtained; 6,600 bales of cotton went to Saint Louis via the Saint Louis, Iron Mountain and Southern Railroad. The remaining 3,200 bales went out of the river, finding a market at Memphis or New Orleans. The value of its receipts is somewhat in excess of the value of its shipments. Judsonia, at the crossing of the Saint Louis, Iron Mountain and Southern Railroad, and 39 miles from the mouth of the river, has a population of 425.

It shipped last season 1,512 bales of cotton, of which nearly all went to Saint Louis; also, 4,000 pounds each of green and dry hides and 5,000 pounds of wool; also, some fruit. There is a mill at this place capable of turning out 10,000 feet of lumber per day.

The railway bridge has a draw span. The length of this span is 262 feet 9 inches, and the distance between piers is 116 feet. The elevation of the lower chord above high water is 6 feet 6 inches, and above low water 42 feet.

West Point, 30 miles from the mouth, is practically the present head of navigation. There has been but one boat above it in several years. It is a town of about 125 inhabitants and handles about 400 bales of cotton annually. It is little more than a shipping point for Searcy, with which it is connected by a horse-car railway crossing the Iron Mountain Railroad at Kensett.

CONDITION OF THE STREAM.

The river between Searcy Landing and West Point has an average width of 300 feet. Its banks at no point have an elevation of less than 25 feet, and do not cave. Its bottom is generally rocky.

There are on this reach three shoals, which at low water cannot be passed with a skiff. Whittle's Shoal, 4½ miles below Searcy Landing, is 200 feet long, and consists of a solid ledge of rock covered with loose bowlders and *débris*.

Judsonia Ford, at and above the town of Judsonia, is a very formidable obstruction. It consists of a series of ledges crossing the river at right angles and covered to a greater or less extent with loose rocks and bowlders. Its entire length is not much less than a mile.

Utley's Shoal, 4 miles below Judsonia, consists principally of loose rock. There are two main deposits separated by about 2,000 feet of clear river, having a depth of 4 feet. Deep water, with occasional large bowlders, is encountered almost immediately above and below.

The river at these shoals can, during low water, be crossed dry shod. They act as dams, and the water in the pools between them has no perceptible current. The examination having been made without the use of instruments, the differences in elevation of these pools could not be definitely determined. From the best data at hand the total fall from Searcy Landing to West Point is estimated at 12 feet. These shoals during the three months of high water offer no obstruction to the passage of boats.

There are on this reach thirty-seven snags, and one hundred and fifty leaning trees over one foot in diameter, besides many smaller ones, which would, were there no shoals, be considered as obstructions to navigation.

Below West Point the river has an average width of 225 feet, with a bank elevation of about 25 feet. Its bottom is generally sandy, with some gravel and occasionally bowlders. It has little or no fall; water from the White River backs up to West Point the year round. Knight's Bar, 20 miles from the mouth, is the only shoal in this portion of the stream. It is composed of sand, gravel, and scattered bowlders. The minimum depth of water that obtains upon it is 22 inches. Its length is about 300 feet. At ordinary low water it is readily passed by the steamer Hard Cash, of the Memphis and White River Packet Company, on her regular weekly trips to West Point. During unusually dry seasons there are, however, about two months when she is unable to cross it. There are on this reach 371 snags, and 555 leaning trees over 1 foot in diameter, besides many smaller ones, which are obstructions to its navigation.

IMPROVEMENTS.

It is not thought best, in making an estimate of the cost of improving this stream, to provide for work above Judsonia. Very little good could result from the removal of loose rock from Whittle's Shoal and Judsonia Ford, and to cut a channel through them would not only be an expensive work, but would drain the pools above. The construction of locks, the only means by which low water navigation is possible, is not warranted by the benefits which would thereby be derived. The discharge of the stream, except during freshets, is insignificant, and backwater from the White, which alone at other times makes the Little Red a navigable stream, does not, at ordinary stages, extend farther than Utley's Shoal. During high water in either stream these shoals can be passed in their present condition.

It remains, then, to remove the snags and leaning timber below Judsonia, to remove the bowlders from and to deepen the channel over Knight's Bar, and to open a passage for boats through the loose rock at Utley's Shoal. This done, it is thought the boats can reach Judsonia eight months in the year and West Point at all times. Two flat-boats, one carrying a crane and capstan, with the ordinary appliances for removing snags and bowlders from the beds of small streams, and the other quarters for a working party, will constitute a plant well suited to this work. I submit the following:

ESTIMATE OF COST.

Plant	$3,000
Removal of snags and leaning timber below Judsonia, three months' work, at $1,200	3,600
Improvements at Utley's Shoal	7,500
Improvements at Knight's Bar	2,000
	16,100

Respectfully submitted.

F. W. TUTTLE,
Assistant Engineer.

Capt. T. H. HANDBURY,
Corps of Engineers, U. S. A.

APPENDIX R.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN THE MOUTHS OF THE ILLINOIS AND OHIO RIVERS—IMPROVING HARBOR AND MISSISSIPPI RIVER AT ALTON—ICE-HARBOR AT SAINT LOUIS, MISSOURI—IMPROVING MISSISSIPPI RIVER AT OR NEAR CAPE GIRARDEAU, MISSOURI, AND MINTON POINT, ILLINOIS—IMPROVEMENT OF OSAGE RIVER IN ARKANSAS AND MISSOURI.

REPORT OF MAJOR O. H. ERNST, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Mississippi River, between the Illinois and Ohio rivers.
2. Harbor and Mississippi River at Alton.
3. Ice-harbor at Saint Louis.
4. Mississippi River at or near Cape Girardeau, Missouri, and Minton's Point, Illinois.
5. Osage River, Kansas and Missouri.

EXAMINATIONS AND SURVEYS.

6. Fish Bend near Fort Chartres, in the Mississippi River.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., August 24, 1882.

GENERAL: I have the honor to transmit herewith the annual reports for the fiscal year ending June 30, 1882, upon the works under my charge.

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

R 1.

IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE ILLINOIS AND OHIO RIVERS.

In carrying out the programme, definitely adopted last year, of making the improvement continuous, working downstream from Saint Louis, work has been carried on during the year at Arsenal Island, Horsetail, Carroll's Island, Twin Hollows, west bank, Twin Hollows, east bank, Beard's Island, and "Jim Smith's."

Plate I is a general map of the river between the Saint Louis bridge and Kimmswick, a distance of 22 miles, which shows the location of these places.

ORGANIZATION.

To provide for the enlarged operations of the latter half of the year it became necessary to reorganize the administrative staff. A superintending engineer was assigned to the general supervision of all the works and of the supply depot, while at each locality there was stationed a resident engineer with one or more assistants. The superintending engineer had his office in Saint Louis and was in almost daily consultation with myself. His prescribed duties were to advise and direct the resident engineers and to have special charge of the procurement of brush and stone, and of the tow-boat and barges engaged in that work. The resident engineer was provided with quarters and an office at the work. His prescribed duties were to have immediate direction of the work of construction, to make such surveys and observations as might be required to keep the progress map upon which all work was to be located as fast as constructed; to keep the journal and other records of the work; to prepare the pay-rolls; to render the quarterly property returns; to make requisitions for material required and reports of material received; to supervise the kitchens, mess-rooms, and quarters; and to render the weekly, monthly, semi-annual, and annual reports to the officer in charge, required by existing regulations, forwarding them through the superintending engineer. He was aided in these duties by assistants whose number depended upon the magnitude of the work. Notwithstanding the fact that the organization was new and many of the assistants were without experience, it has worked with great smoothness. The works have made good progress, a minute record has been kept of exactly where and how each kind of work was being done and what it was costing, and a force of about 1,100 men has been cared for in a country destitute of shelter and supplies, while one tow-boat sufficed to supply all the works.

A few changes in the assignments were made after the season opened. At the end of the year they were as follows, viz:

Superintending engineer, Mr. D. M. Currie.

Resident engineers:

At Arsenal Island and Horsetail, Mr. A. Freis, assisted by Mr. J. L. Stubblefield.

At Carroll's Island, Mr. C. V. Mersereau.

At Twin Hollows, east bank, Mr. C. V. Mersereau, assisted by Mr. A. W. Chase and Mr. J. W. Irwin.

At Twin Hollows, west bank, Mr. W. S. Mitchell, assisted by Mr. John L. Duffy and Mr. S. B. Cady.

At Beard's Island, Mr J. W. Record, assisted by Mr. J. E. Savage.

At "Jim Smith's," Mr. John O. Holman, assisted by Mr. E. D. Libby and Mr. B. E. Johnson.

At the supply depot, Mr. S. S. Van Norman had charge of the subsistence department, and Mr. C. L. Stevenson, of the engineering supplies and repairs.

On board the steamer Humphreys, Mr. C. P. Mitchell acted as general receiver of materials and measured the brush and stone.

The reports of Mr. D. M. Currie and of the resident engineers are herewith transmitted, and are intended to form part of this report. They constitute Appendixes A, B, C, D, E, F, G, H, and I, of this report. They give so fully all the details of the works, that but little more will be required here than to give the reasons for each work and its results, so far as they have as yet been attained.

While all of these gentlemen have shown great intelligence and zeal in the discharge of their duties, the services of Mr. Currie have been of exceptional value.

First Lieut. F. V. Abbot, Corps of Engineers, reported to me for duty just before the close of the fiscal year, and was assigned to the study of special questions of great importance in the economical prosecution of the works.

SUPPLY DEPOT.

Under the authority of the honorable Secretary of War, dated January 4, 1882, the strip of ground cut off from the old arsenal grounds in this city by the Iron Mountain Railway, and lying between the railway and the river, was taken possession of by the Engineer Department, to be used as a depot of supplies for the works under my charge.

The authority for occupying the ground was given with the following condition:

> But it should be distinctly understood that the Quartermaster Department for the landing and shipment of supplies at the depot shall retain its present rights and privileges thereon. This right may, in case of extensive military operations, become very important to the economical handling of supplies for troops.

The necessary shops and store-rooms were immediately erected (see Appendix I), and improvements were made in the landing with a view to facilitating shipments. With the latter object the retaining wall which obstructed communication with the river was partially demolished, the wall being cut down 6 feet from the top over a portion of its length; and a hurdle was run out into the river to cause deposits in front of the wall. The object of both pieces of work was to finally secure an inclined plane of gentle slope, against which boats can land at all stages.

The establishment of this depot has rendered it possible to make purchases upon favorable terms, and to supply the works with regularity and at a minimum cost both for materials and transportation. It has given also much needed facilities for fitting out and repairing the equipment.

The expenditures upon the depot itself were $7,494.32.

ARSENAL ISLAND PROTECTION.

The first shoal which formerly existed below the Saint Louis Bridge was at the head of Arsenal Island, and the second one at the foot of the same island. The submergible dam thrown across the East Chute, or Cahokia Chute (see Plate I), in 1878 and 1879, has removed both of these shoals, there having been not less than 9 feet of water upon either of them at the lowest stage reached during the past year. The enlarged volume of water thrown into the West Chute rendered it necessary to revet the west side of the island. Simultaneously with the construction of the dam, the protection was begun at the upstream end of the island, the downstream portion being left unprotected in order to allow the chute to widen out to the full width of 1,500 feet, the width adopted for the part of the river lying within the limits of Saint Louis. The protection was extended downstream at intervals as the erosion reached the desired limit. The work this year has been to still further extend it.

At the beginning of the year the work had been completed to the point A (Plate II), a distance of 950 feet from the head of the island. A partial revetment had been placed from A to B, a distance of 3,500 feet, but only the portion below a level 7 feet above standard low water had been constructed, the upper portion of the bank having been left unprotected until it should be graded to a gentle slope by the action of the river. This grading having been accomplished, the work of completing the revetment by extending it up the bank was begun in November last. A layer of riprap about 1 foot thick was placed upon the bank, completing the protection to a height of 16 feet above standard low water.

The old protection having been completed, the work of extending it downstream was begun this spring. The flow of the stream here being parallel to the bank, it was not considered necessary to extend the protection to the great width below low water required in other circumstances. Mattresses 40 feet wide were placed below low water mark for a length of 2,750 feet, C to D. Just below the old work there was an indentation, B C, 325 feet long, in the shore, which it was thought best to fill up in order to give it a smoother outline. To accomplish this three short hurdles were constructed.

To complete this work there remain to place the footing mattress for a length of about 625 feet, and to deposit riprap upon the bank above low water for a length of 3,375 feet.

The expenditures were $14,513.88.

HORSETAIL.

The third, fourth, and fifth shoals below Saint Louis were found in the reach known as Horsetail. The works for the improvement of this locality have been under way for a number of years, and have been fully described in former reports. They have for their object to contract the river to a width of about 2,500 feet by reclaiming land and building up new banks, and, as the result of such contraction, to obtain a low water depth of at least 8 feet. They are shown on Plate III, which, when compared with Plate II of my last annual report, shows the progress made during the year. On the Illinois side the primary hurdle was extended downstream until it reached shoal water, the unfinished secondary hurdles were extended to intersect the primary one, and an additional secondary hurdle, No. 30, was constructed. On the Missouri side the primary hurdle was begun and extended downstream as far as was considered necessary, and the secondary hurdles were completed.

The prolonged high water of last autumn and this spring has caused numerous small breaks in the hurdles, many of which it has not been considered necessary to repair, on account of the heavy deposits which had already been secured. In reconstructions and repairs a more substantial form of construction is employed than that used at first.

The high water which has continued during the greater part of the year has prevented the growth of willows at the lower levels and the consequent consolidation of the new-made land. At the lower end of the reach there has been some loss, but upon the whole the process of building up the new banks has continued in a satisfactory manner. It is difficult to show this clearly upon a map small enough to be suitable for publication. Plate III shows the deposits as they appear at a 15-foot stage, and Plate IV as they appear at a 12-foot stage, Saint Louis gauge. On the latter plate the outline of the bars, as they appeared at the beginning of the year as well as at the end, is given. On the Illinois side almost the entire area above hurdle No. 15 has reached a height of more than 20 feet above low water of 1863, many acres of it being more than 25 feet. The same may be said of the Missouri side above No. 6. The heavier deposits secured during the year upon the Missouri side are due to the fact that upon that side of the river the water is at all seasons from the Missouri River, while on the Illinois side the water is often from the Upper Mississippi, almost undiluted.

The beneficial effect upon the channel has been very marked. Of the three principal reefs which were prominent last year the first and third had entirely disappeared when the water fell in August, 1881, there being a low water depth of from 15 to 30 feet at the places where they were found. During the short low water season of last August the middle reef assumed a troublesome form, its Missouri end retaining nearly its former position, but its Illinois end swinging down stream so as to give it a total length of nearly 2 miles. There were three depressions or channels through it, the depth of water in the one followed by steamboats being sometimes equal to and sometimes less than that in the others. A depth of but 6 feet having been reached in the channel usually followed by steamboats, it was decided to deepen it in order to aid the river to concentrate. The water jet was applied with remarkably great and prompt results (see Appendix A), an additional depth of 2½ feet being gained in ten hours' work. On the 12th of August, 1882, with the river at a stage 11½ feet above standard low water, there was a least channel depth of 20 feet throughout the Horsetail Reach, the channel being direct and wide. This would give a depth of 8½ feet at low water, supposing that the bottom does not scour as the river falls, as it usually does. But a better idea may be obtained of the result by comparing this depth with that found on the same day upon other bars between Saint Louis and Cairo. The depths reported by the pilots of the steamer City of Helena were 8 feet upon three bars, 12 feet or less upon eight others, and 15 feet or less upon seven others.

The result sought for at this place has therefore been attained. But it must not be understood that the work is finished. Before the new deposits can be regarded as secure, they must be protected both on top and on the channel sides. The protection on top will consist of a growth of willows, which, it is thought, can be obtained without expense by spontaneous growth. A considerable area has not yet reached a height at which the willow will grow. The hurdles must be kept in repair, and possibly additional ones constructed until such a height is reached. The amount of protection that will be required on the channel side is a matter of future contingency. The lower portions of the deposits are protected by the lower parts of the piles and the mattress-work placed in connection with them, but the vertical face presented by the hurdle does not offer a good protection for the upper portions. It will sooner or later be destroyed by ice or by decay. For considerable distances deposits have already been made outside the works, and it seems probable that as the channel settles down in one well-defined location away from the works these outside deposits will be extended. In such cases no further protection will be required. But where the water-way at low and medium stages remains permanently in contact with the work, it will be necessary to replace the primary hurdle by a layer of riprap deposited upon the slope of the new bank. It is possible that the time for work of this kind has arrived for the Missouri side, but that cannot be determined until the river has reached a lower stage than the present. For the Illinois side, it is thought that it should be deferred for at least another year.

The expenditures at Horsetail were $98,553.23.

CARROLL'S ISLAND PROTECTION.

After the high water of July, 1881, the channel was found crossing from the Missouri shore to the foot of Carroll's Island, which it was rapidly undermining and washing away. It was necessary to protect the west side of the island near its lower end. The case presented was one analogous to that of a caving bend, where the direction of attack of the stream is at an angle with the bank; the width of protection below low water for such cases was fixed at 120 feet. The details of construction designed to meet these cases are shown on Plate XIV, and will be described further on. A single mattress, 120 feet wide and 1,695 feet long, was constructed and placed in position, as shown on Plate X.

The extension of the revetment up the bank was rendered unnecessary by a heavy deposit outside of it, which occurred during the high-water of November.

The expenditures here were $12,038.69.

TWIN HOLLOWS, WEST BANK.

The locality known as Twin Hollows extends from the foot of Carroll's Island to the head of Beard's Island (Plate I), a distance of about 3½ miles. It is immediately below and adjoining Horsetail. Issuing from the foot of Carroll's Island, with a width well adapted to good navigation, the stream gradually widens out, until just above Beard's Island it has a width of 6,350 feet between banks. This great width has the same result here that it has elsewhere, viz, great deposits in the bed during high water and feeble scouring power as the water falls, the consequence often being a badly obstructed navigation during the low stages of the autumn. These deposits being irregular in shape and movable, the obstructions are not always found in the same place, and they do not always exist in the same degree. They have sometimes been found opposite Twin Hollows, and sometimes opposite the head of Beard's Island. At either or both of these places the channel depth is liable to be as little as 4 feet, and if deep water happens to exist at these particular points, the shoals are liable to be found somewhere between them. It sometimes happens that from the peculiar form of the deposits, or the lightness of the material, or a natural concentration of the water, or other causes, the scouring power is sufficient to cut out the deposits in the channel before the stage of water has fallen so low as to make them obstructions to navigation. In the autumn of 1879 a channel depth of but 4 feet 4 inches was found opposite the head of Beard's Island, the river being at a stage 3.8 feet above standard low water, while in 1880 no obstruction was met with, and in 1881 the least depth was 6½ feet, the river being at a stage 4.75 feet above standard low water. It promises to be as bad this year as it was in 1879, if not worse.

The plan adopted for the improvement was simply a continuation of the general plan for the improvement of the navigation between Saint Louis and Cairo, viz, to contract the river to an approximately uniform width of about 2,500 feet, and to protect the alluvial bank from erosion. In deciding which of the present banks was to be retained and which was to be built out there were no complications of local interest. There was no regular steamboat landing upon either bank. The question was narrowed down to one of cost and of convenient use of the river for navigation during the execution of the works. The rocky bluff of the Missouri shore constitutes a bank that it is certainly very desirable to retain, and if circumstances could justify the expectation that the opposite bank could be pushed out without much greater effort than in the case of the Missouri bank, there would have been little difficulty in deciding. Unfortunately, the circumstances were opposed to such an expectation. The channel was found on the Illinois side, or near it, all the way from Carroll's Island to the foot of Beard's Island (see Plate VI), a distance of over 4 miles. In no case throughout this distance did it approach the Missouri shore to a distance less than 2,500 feet, and for a considerable portion of the length it was over 3,500 feet distant. The space between the channel and the Missouri shore was largely occupied by sand-bars, which were dry at a stage 5 feet above standard low water. The waterway between them and the Missouri shore was in many places insignificant at a 5-foot stage, and entirely obliterated at low water. If the Missouri shore had been retained it would have been necessary to excavate a practically new bed for the river and to fill up the greater part of the present bed. This could have been done, but it would have been a difficult and costly undertaking, and it could not have failed to cause great annoyance to those engaged in navigating the river. A much easier and simpler plan was to build out where it was shoal, preserving the deep water where it was. This plan was adopted with the less hesitation when to the foregoing was added the consideration that no attempt should be made to hold the river against the bluff all the way to Sainte Genevieve. To do so would be to shorten the river several miles, greatly magnifying the difficulties and expense of the whole work, increasing the slope and obstructing ascending navigation. To push the river in against the bluff at Twin Hollows would probably push it away from the bluff below and spoil the present favorable condition of affairs between Kimmswick and Rushtower, where for 15 miles the channel closely follows the bluff.

It was therefore decided to hold the present Illinois bank as far down as the point I (Plate VI), using a revetment where it was needed to build up a new bank on the line I K to the head of Beard's Island, and to revet the west side of that island. Using the line thus constructed as a directrix, the Missouri shore was to be built out to an approximate distance of 2,500 feet from it.

For convenience in administration the works on the different sides of the river were placed under separate organizations. That on the west side was begun in September, and was continued, under many difficulties (see Appendixes A and D), until the close of the fiscal year, except during the winter months. The works as they were at the end of the year are shown on Plate VI. The primary hurdle had been partially constructed for a length of about 8,800 feet from its upstream end, of which about 5,000 feet had been completed. Four secondary hurdles had been nearly completed. Owing to the rocky nature of the bed near the Missouri shore, into which piles could not be driven, it was necessary to devise special forms of construction (Plates VIII and IX) to meet the case. The resulting delay in connecting the lines with the shore was a serious drawback. Nevertheless, large deposits have been secured within the area to be reclaimed. The works have not progressed far enough to exert any effect upon the channel.

The heavy caving of the Illinois bank below Carroll's Island, combined with the prolonged high water of last autumn, threw a vast quantity of solid material into the channel, and finally this spring forced it out of the location which it had occupied, opposite Pull-tight, and caused it to cross over to the Missouri shore, as shown on Plate VI.

This change will render it undesirable to push the work at Twin Hol lows as rapidly as was at first intended. The channel now occupies ground which it is intended to reclaim, and the encroachments upon it must be slow and gradual. The caving above has been stopped by the work on the east bank, the crossing has worked downstream fully one-half a mile in the last two months, and it is thought that the channel can be brought back to its former position without great effort.

In order, however, to avoid obstructing navigation, the work must progress slowly.

The expenditures at Twin Hollows, west bank, were $103,500.25.

TWIN HOLLOWS, EAST BANK.

The Illinois bank, below Carroll's Island, which had been comparatively stationary for a number of years, began caving with great rapidity in the summer and autumn of 1881.

Before this could be stopped a strip of land about 8,400 feet long and varying in width from 50 to 300 feet was destroyed. The channel crossing from the Missouri shore struck the bank at an obtuse angle, presenting the case where a wide and deep protection was required. The width of the mattress to be placed below low water mark was fixed at 120 feet.

The work was begun in October, and was still in progress at the end of the fiscal year. At that time three mattresses had been placed below low water mark, as shown on Plate XI, one 1,493 feet long, one 3,800 feet long, and one 1,325 feet long. A fourth mattress was under construction, and had reached a length of 964 feet, but no portion of it had been sunk. The 6,618 linear feet of mattress placed covered 5,925 linear feet of the bank, the difference being due to the overlap of contiguous mattresses. The downstream end of the second mattress was so badly damaged in sinking that it was necessary to overlap it several hundred feet. The extension of the protection up the face of the bank was not made continuous. The upper part of the bank was usually vertical where the low water mattress was placed. The latter immediately stopped the undermining, and the further erosive action of the river helped the work by grading the upper part of the bank to a gentle slope. This action was carefully watched, and whenever the grading was completed to the desired slope riprap was deposited upon the bank above low water, thus completing the protection. A total length of 2,350 feet was thus completed. For details of this work and the difficulties encountered see Appendixes A and F.

The bank was for the greater part of its length covered with large trees, which, after falling into the water, constituted obstructions in the way of laying the mattress which it was necessary to remove. The snag-boat General Barnard, with crew, was temporarily transferred to me for this purpose by Major Mackenzie under the authority of the department. She was engaged for several weeks in September and October, her expenses being paid out of the appropriation for the work. These, amounting to $1,663.40, are included in the statement of expenditures below. She removed one hundred and thirty-five snags from the water, and her crew cut down two hundred and ninety-six trees which were standing, but were about to become snags as the caving progressed. Work of this character was again required in the spring. The snag-boat Wright, being engaged in the vicinity in removing snags from the channel, removed also these obstructions, under orders from Maj. Charles R. Suter, Corps of Engineers, to whom I am indebted for that assistance. There was no expense to the appropriation for the work for the services of the *Wright*.

To complete the work there remained to be placed about 2,500 feet of low water mattress, of which 964 feet was already fabricated, and deposit riprap upon a length of about 6,075 feet of the bank. Hurdles to close the small chute below Pull-tight will also be required. It is expected to accomplish this during the present working season.

The expenditures were $72,696.63.

BEARD'S ISLAND.

The protection of the west side of Beard's Island and the closure of the small chute north of the island constituted a part of my project of January 28, 1881, for the improvement of the river between Carroll's Island and the mouth of the Meramec. The bank was caving at that time, and it continued to do so until it was stopped by the work of this year, a strip of land about 7,500 feet long and in many places 800 feet wide having been destroyed since October, 1880.

The case presented for the bank protection was similar to that at Carroll's Island and Twin Hollows, east bank, and the same width of mattress, 120 feet, to be placed below low water mark, was adopted. The work was begun about the end of March, and was in progress at the end of the fiscal year.

Three mattresses 120 feet wide were placed as shown on Plate XII, one 3,250 feet long, one 360 feet long in prolongation of the first, and one 300 feet long, used to cover a break in the first mattress which occurred in sinking. A fourth mattress was under construction at the end of the year, and had reached a length of 550 feet, but no portion of it had been sunk. The length of bank which received the low water protection was 3,550 feet. The protection was extended up the face of the bank by a layer of riprap after it was graded to a gentle slope by the erosive action of the river. The length so completed was 1,650 feet.

A hurdle about 1,000 feet long was built in May and June across the small chute north of the island. It was not finally completed until the end of June, although it caused heavy shoaling before it was finished. The river was at flood a few days afterwards. When the water fell to a 28-foot stage it left the chute dry, a vertical fill of over 40 feet having occurred within a few weeks. Considering the high level of the top of this deposit and the short length of time required to secure it, this is the most remarkable result yet accomplished by hurdles on the Mississippi. For details of the work see Appendixes A and G.

There remained to complete the work the placing of about 3,950 linear feet of mattress and the placing of riprap upon the bank above low water for a length of 5,850 feet. It is expected that this can be accomplished during the present working season.

The expenditures at Beard's Island were $35,614.53.

"JIM SMITH'S."

The eighth and ninth shoals below the Saint Louis Bridge are found in the reach just below Beard's Island, and extending to Kimmswick, a distance of about 3½ miles, known to steamboat men as "Jim Smith's." (See Plate I.) The conditions here are similar to those above described for Twin Hollows, except that in this case there is a regular steamboat landing on each side of the river, Kimmswick on the west side and Smith's Landing on the east. The width between banks varied from about 4,000 to about 7,000 feet. The least channel depth found in 1879 was 6 feet; in 1880, 7 feet; and in 1881, 6½ feet; the stage of the river in all cases being more than 4 feet above standard low water.

A project for the improvement of the locality was forwarded to the department with my letter of September 12, 1881, and was approved by department letter of November 2, 1881. The plan was in general the same as that for other localities, viz, to reduce the width of the river to about 2,500 feet. The selection of the lines for the new banks was controlled by the following considerations, viz: 1st. The location of the channel was for the greater part of the distance on the west side of the the river, and thus favored building out the east bank. 2d. To build out the east bank, while preserving the natural length of the river, would bring it smoothly against the rocky bluff at Kimmswick. 3d. The Kimmswick Landing is of more importance than Smith's Landing, on the opposite side, the former being a flourishing town of about 800 inhabitants, while at the latter there are but a few scattered farm-houses, the landing itself being located upon an alluvial bank, subject to erosion. It was necessary to interfere with one landing or the other, and the latter was selected. It was accordingly decided to take as the new right bank the east side of Chesley Island, as far down as about its middle, from which point the direction is to be a straight line tangent to the rocky point at Kimmswick. (See Plate I.) The new left bank is laid out parallel with it and 2,500 feet distant. The chutes between Chesley Island and the Missouri shore are to be closed at the lower ends, the upper ends being left open to provide an exit for the Meramec River, and also a catchment basin for the gravel brought down by that stream.

The steamboat landing at Smith's is thus temporarily cut off from navigable water until the works shall have accomplished their object of building up the new bank. This will occasion some inconvenience to the people of that neighborhood for one or two seasons, but will finally result in giving them a more secure landing than the present one, which is often difficult of access. In cases of this kind, which will no doubt occur frequently as the improvement advances, it is proposed to place the piles so that a pier can be constructed upon them by those who require access to navigable water.

It was determined to begin this work when it had become evident that the work at Twin Hollows, west bank, could not be pushed to completion this season. It was begun in the latter part of May, at the point F, Plate VI, on the Illinois side. The initial point was made here instead of at the foot of Beard's Island, for the reason that the distance from the point F was less than from F to the island, and it is expected that the space below the island will be filled up without further work when the hurdles below Pull-tight shall have finally closed the east chute. The direction of the line F F, oblique to the shore, is given to facilitate construction by favoring the removal of drift-wood. When the work was begun it was expected that the high water, which had lasted with slight intermission for nearly a year, was about to come to an end. This proved not to be the case, and the work was much obstructed until the end of the year. At that time the primary hurdle had been constructed for a length of about 1,000 feet. Although the cost of the work was great, its results were prompt and large, heavy shoaling having been caused within the area to be reclaimed. Special forms of construction were used to meet the difficulties occasioned by high water. They are shown on Plate XIII, and are described in Appendixes A and H. The work has not advanced far enough to exert any effect upon the channel.

The expenditures were $11,068.37.

DICKEY'S ISLAND TO THE MOUTH OF THE OHIO.

No work was done upon the protection in rear of Cairo, and it is here mentioned merely as an illustration of the inutility, so far as the navigation interest is concerned, of working at detached points upon the river. The bend in which the caving bank was protected has now been deserted by the channel and is rapidly filling up, the greater part of it being dry at a 20-foot stage. The work done there, however valuable it may have been to the city of Cairo, has been of no permanent value to the navigation interest. The amount expended there, $119,868.66, must now be added to the estimate for improving the navigation between the mouths of the Illinois and Ohio rivers.

CONTRACTION WORKS.

The works at Horsetail, Twin Hollows, and "Jim Smith's" have been of the same general character as those used in former years at Horsetail, viz, a well-braced hurdle, built upon the line of the proposed new bank, called a primary hurdle, and connected at intervals with the shore by hurdles called secondary hurdles, built upon lines perpendicular to the primary hurdles. The principal modification in their use has been to increase the strength and diminish the number of the secondary hurdles. Greater strength was found necessary to enable them to resist the heavy masses of drift-wood which are liable to accumulate against them at every rise. It has been attained by thorough bracing and a foundation mattress of brush. This added strength has rendered less necessary their mutual re-enforcement, and the interval between them has accordingly been increased to 2,000 feet.

The height to which they are built, where there is any choice in the matter, has also been modified. The height at first adopted was 15 feet above low water of 1863, the reasons for fixing upon that height being that above that level willows would grow, and would prove a more durable silt-catching arrangement than the hurdles. These reasons still exist, but the necessity of extending the working season over periods when the river is at a higher stage has made a modification necessary. While a hurdle is in process of construction it is necessary that it should be visible; that is, that its top should project above the water surface. The higher the stage, the higher must the hurdle be built. To carry it just to the water surface and then stop would cause great irregularity in the heights. This is objectionable for the reason that if one hurdle projects very much above the others it will be subjected to unusual strains from drift-wood at times when the others are submerged. Absolute uniformity in height is not attainable without fixing as the standard the highest stage at which the work may be carried on. The advantage to be gained by this would not compensate for the great additional expense. A reasonable uniformity in ordinary years can be attained by fixing the height at 16 feet above standard low-water, and that is the height which has been adopted.

BANK PROTECTION.

The solution of the problem of protecting alluvial banks from caving and erosion must differ according to different circumstances. It is evident that where the main channel flows parallel to the bank, as in a narrow and straight part of the river, the circumstances are entirely different from those where it crosses from one side of the river to another and strikes the bank at a very obtuse angle. In the former case there will be a gradual wear of the bank, which will extend down to but a moderate depth, resulting from the friction of the water against the light, uncompressed soil. In the latter case the bank lies in the path of the channel instead of at one side of it, and has, in addition to the friction, to resist a series of blows as from a jet; the deepest water is found near the shore, the bank is rapidly undermined, and heavy caving results. These circumstances are usually found in a concave bend. It is evident that in this case the protection must extend down to a much greater depth than in the former.

In both cases a permanent protection can be most economically obtained by dividing the bank into three zones, which are nearly horizontal, the lower zone extending from the lowest limit of erosion up to low water mark, the middle zone from low water mark up to the level at which a live growth of willows will flourish, and the upper zone extending from the latter level to the top of the bank. The lower zone, being always covered with water, may be permanently protected by a brush mattress. In the second or middle zone, which is subjected to constant alternations of wetting and drying, due to the oscillations of the river, a protection of brush must necessarily have but a brief life; in this zone a layer of riprap is required. In the upper zone a live growth of willows will form an efficient and permanent protection. To prepare the bank to receive the protection, it is graded to a gentle slope.

The difference in the method of construction adopted in the two cases lies entirely in the construction of the mattress to be placed below low water mark. In the first case a width of 35 or 40 feet is sufficient, and as the current near the shore is usually moderate, like the depth, no great difficulties are presented. Such a case was found at Arsenal Island. The method adopted is described in Appendixes A and B. In the second case the width of the mattress must be much greater, and as the depth and velocity of the water are greater, the difficulties of placing the mattress in proper position so as to give a continuous covering to the bank are much increased. To insure continuity, but few mattresses, and these of great length, must be provided. The design prepared to meet the general requirements of this case is shown on Plate XIV. A depth often found in a caving bend is 40 feet at low water. Allowing the slope of the bank below the water surface to be 1 on 2½, the distance from low water mark to the bottom of the river, measured on the slope, is about 110 feet. A mattress of that width would be sufficient to cover the slope if its upper edge could be placed exactly on the low water line. Practically that is impossible. The edge of the mattress must be in plan a smooth line, with easy changes of direction, while the low water line is usually very irregular in direction. The upper edge of the mattress, when placed, will, in some cases, fall below the low water line, and in some cases above it. To provide for these irregularities and insure reaching the foot of the bank at all points, a slight additional width is required. The width of the mattress is fixed at 120 feet, its length to be as great as practicable. It is fabricated upon floating ways prepared for the purpose, having their slope up and down stream. The mattress is launched progressively as it is constructed, the ways being pulled out from beneath it and moved a short distance downstream, retaining the downstream end of the mattress, but leaving the balance of it floating upon the water. It is securely fastened to the line of guide-piles near the shore. By this method the only limit to the length of the mattress that may.be constructed, if the difficulty of sinking be left out of account, is the length of the working season.

Where the depth and velocity are not excessive, it is possible to sink the upstream portion, leaving the downstream portion still upon the surface of the water, and thus by progressive sinking to place in position on the bank a mattress of very great length. Mattresses 3,800 feet long and 3,250 feet long, respectively, were placed this spring at Twin Hollows, east bank, and Beard's Island, the downstream end of the first, however, in a damaged condition. This exposes a portion of the mattress to heavy strains from the current, and in many cases these will be great enough during the higher stages of the river to wreck its downstream end. In such cases the length is limited to the amount that it is possible to sink in a single operation. In the original design this limit was fixed at 1,000 feet, but in practice it has been exceeded. One mattress 1,325 feet long, and another 1,500 feet long, completed after the close of the fiscal year, have been successfully sunk in a single operation at Twin Hollows, east bank.

The method has been subjected to as severe tests, both as to difficult circumstances of execution and as to subsequent efficiency, as it will probably ever receive, and it has proved highly satisfactory.

METHOD OF CARRYING ON THE WORK.

All work during the year has been done by hired labor and purchase of material in open market. It is proposed to continue the system during the coming year, for the reason that the character of the work will not admit of the contract system without injury to the interests of the United States. The reasons for this were fully set forth in my annual report for 1880. (See Annual Report of Chief of Engineers for 1880, pages 1374, 1375.)

EQUIPMENT.

The principal additions to the equipment during the year were the completion of the fourteen steam pile-drivers begun last year, the construction of two sets of floating ways for bank protection, thirty-seven portable buildings for quarters, eighty small flats, and one hydraulic excavator, and the purchase of two second-hand coal-barges, forty-two yawls, and eighty-two skiffs. The equipment is now adapted to the scale of operations provided for in the river and harbor act of March 3, 1881, that is, for an expenditure of $600,000 per year. A special record is kept, in which it is treated as so much unexpended appropriation, each work being charged for the use and repair of such as may be employed upon it.

The present valuation of the property remaining to be distributed in the future is given in the last column of the following table, in which are given also its valuation at the beginning of the year, the sums which have been expended upon it, and its estimated deterioration during the year:

Class of property.	Balance July 1, 1881.	Dr.	Cr.	Balance June 30, 1882.
Steamer A. A. Humphreys	$18,914 17	$4,408 52	$2,123 53	$21,199 16
Steamer Anita	4,851 97	809 66	2,751 41	2,910 22
Launch Hornet	105 71	286 92	286 07	106 56
Tug Mignon	4,077 72	....	....	4,077 72
Barges	71,320 17	37,038 44	25,851 24	82,507 37
Pile-drivers	33,176 55	29,461 68	7,217 40	55,420 83
Quarter-boats, quarters, shops, &c	15,445 05	31,994 92	5,740 51	41,699 46
Skiffs, flats, &c	1,764 98	14,119 88	2,854 29	13,030 57
Tools and appliances	4,411 82	7,014 61	4,185 43	7,241 00
Hydraulic excavator	....	8,538 31	1,079 98	7,458 33
Ways for mattresses	....	6,461 17	750 08	5,711 09
Office furniture	441 95	592 25	120 84	913 36
Surveying instruments, &c	1,114 95	636 91	....	1,751 86
Boarding outfit	....	12,501 14	142 19	12,358 95
Totals	155,625 04	153,864 41	53,102 97	256,386 48

The hydraulic excavator consists simply of a powerful steam pump (see Appendix I), placed upon a scow and furnished with the necessary boiler power and hose for throwing powerful jets of water, its principal object being to grade the banks for receiving a revetment. The boiler is 20 feet long, 42 inches diameter, with two 14-inch flues, and has a nominal 25-horse power. The pump provides two jets, thrown from 2-inch nozzles, the water being conducted from the pump to the desired point through flexible 4½-inch 6-ply hose. The nozzle used and the arrangement devised for guiding the stream are shown on Plate XV. With this arrangement the stream can be guided by one man.

The steamer Humphreys was provided with an electric light, enabling her to work nearly as well by night as by day.

The expenditures upon additions to equipment were $140,134.11.

TELEPHONE LINE.

Telephonic communication between the field offices, the supply depot, and the Saint Louis office having become necessary to the economical prosecution of the works, an arrangement was entered into with the Bell Telephone Company of Missouri, by which they erected a private telephone line on the west side of the river, and engaged to keep it in repair, furnishing all the necessary instruments and apparatus. The line was at first constructed as far as Twin Hollows, and was afterwards extended to the mouth of the Meramec, when the work was begun at "Jim Smith's." Telephone instruments were placed in the offices at 404 Market street, at the supply depot, at Horsetail, at Twin Hollows, and at the mouth of the Meramec. They have been in daily use, and have prevented the necessity of providing an additional tow-boat for supplying the works. The line has also been the means of avoiding innumerable delays in the procurement of supplies, and has brought the works under the close supervision of the main office. The price agreed upon for this service was, for the line from 404 Market street to Twin Hollows, $2,050 for the first year, and $1,055 for each succeeding year, and for the extension to the mouth of the Meramec, $1,190 for the first year and $430 for each succeeding year, or for the entire line $3,140 for the first year and $1,485 for each succeeding year.

SURVEYS.

The general topographical survey, which at the beginning of the year had reached Allen's Landing, 83½ miles below Saint Louis, was resumed in July, and was carried through to Cairo, a distance of 106 miles, before winter, and was thus completed. Two parties were engaged, under the respective direction of Mr. W. S. Mitchell and Mr. John O. Holman. The plane-table sheets were finished in the office during the winter. There is now a series of correct maps, scale $\frac{1}{10000}$, based upon the triangulation of 1874, covering the Mississippi from the Illinois to the Ohio. They constitute a valuable historical record.

The gauges at Grafton, Alton, and Gray's Point were read daily. Their records are appended, marked K, L, and M, respectively. The record of the Gray's Point gauge from August 29 to September 13 is omitted, for the reason that the lower section of the gauge had been disturbed, and it had not been possible to ascertain its error on account of high water.

The expenditures upon surveys and gauge readings were $9,217.17.

NAVIGABLE DEPTH BETWEEN SAINT LOUIS AND CAIRO.

The reports made to the association of Saint Louis and New Orleans pilots by its members have been transferred to me, as last year, and from them has been made a record of the depths found upon the bars between Saint Louis and Cairo throughout the year. So much of it as covers the low water season is herewith transmitted, marked N. As explained in my last annual report, strict accuracy is not claimed for any one measurement. The record, to be of value, should be taken as a whole, several days' measurements, and the gauge records being considered together. The only low water period that occurred during the fiscal year was in parts of the months of August, September, and February, the lowest stage reached being 4.6 feet above standard low water. The least depth reported was 5 feet, and was found at Cairo Point. A depth of 5½ feet was found at Jones's Point and at Eliza Point. Upon all other bars a greater depth was found.

MISSISSIPPI RIVER COMMISSION.

The Mississippi River Commission having expressed a desire to make a formal examination of my works and plans, I was directed by the department to give them all desired information, and in a conference of several days last October I did so. In their report to the honorable Secretary of War, of November 25, 1881, they fully indorsed the plans and the methods of carrying them out. Indeed, in all the discussions which have agitated and confused the public mind upon the subject of plans for improving the navigation of the Mississippi, no professional engigineer has, so far as I know, ventured to question the correctness of the plans adopted by the Engineer Department, and in process of execution at the time the Commission was organized.

ESTIMATE FOR YEAR ENDING JUNE 30, 1884.

Although the appropriation bill for the year ending June 30, 1883, had not become a law at the end of the year, the present estimate is submitted with a knowledge of its provisions. The amount which can be profitably expended during the year ending June 30, 1884, is $1,000,000.

It is proposed to expend it in carrying out the programme described in my last annual report. This is to make the improvement continuous, working down stream from Saint Louis, by reclaiming land and building up new banks, thus reducing the river to the approximately uniform width of about 2,500 feet. It is proposed by this means to secure a minimum depth of 8 feet. The depth is now liable to become as little as 4 feet in some places, and less than 8 feet in every place where the width is greater than 2,500 feet. Alluvial banks are to be protected from erosion. This general statement of the proposed application of the appropriation is as specific as the nature of the case will admit of. The changeable character of the river renders it impracticable to give in advance the exact localities where works will be required.

The work is located in the collection district of New Orleans.

Amount of revenue collected at the port of Saint Louis for the fiscal year ending June 30, 1882, was $1,676,951.56.

Money statement.

July 1, 1881, amount available		$616,809 35
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$466,168 88	
July 1, 1882, outstanding liabilities	38,495 29	
		504,664 17
July 1, 1882, amount available		112,145 18
Amount appropriated by act passed August 2, 1882		600,000 00
Amount available for fiscal year ending June 30, 1883		712,145 18
Amount (estimated) required for completion of existing project		*5,094,288 98
Amount that can be profitably expended in fiscal year ending June 30, 1884		1,000,000 00

Construction account.

Name of work.	Expended prior to July 1, 1881.	Expended during fiscal year ending June 30, 1882.	Total cost to June 30, 1882.
Piasa Island Dam	$32,333 30		$32,333 30
Alton Dam	33,623 92		33,623 92
Sawyer Bend protection	96,803 63		96,803 63
Venice Dikes	36,341 85		36,341 85
Arsenal Island protection	9,673 85	$14,513 88	24,187 73
Closing Cahokia Chute	116,088 60		116,088 60
Horsetail Bar, Dike 1	40,549 53		40,549 53
Horsetail Bar, Dike 2	23,600 26		23,600 26
Horsetail Bar, Dike 3	82,692 54		82,692 54
Horsetail Bar, Dike 4	41,290 11		41,290 11
Horsetail Bar, Dike 5	36,933 87		36,933 87
Horsetail Bar, training wall	80,627 03		80,627 03
Horsetail Bar, primary hurdles, secondary hurdles	205,836 10	98,553 23	304,389 33
Twin Hollows, west bank, primary hurdles Twin Hollows, west bank, secondary hurdles		103,500 25	103,500 25
Twin Hollows, east bank, mattress Twin Hollows, east bank, revetment		72,696 63	72,696 63
Beard's Island, primary hurdles Beard's Island, mattress Beard's Island, revetment		35,614 53	35,614 53
Jim Smith's, primary hurdles Jim Smith's, secondary hurdles		11,068 37	11,068 37
Fort Chartres Dam	36,812 86		36,812 86
Turkey Island	24,463 85		24,463 85
Kaskaskia protection	66,465 62		66,465 62
Liberty Island Dam	5,053 91		5,053 91
Liberty Island protection	45,129 40		45,129 40
Devil's Island, Dike 1	65,871 17		65,871 17
Devil's Island, Dam 1	49,848 58		49,848 58
Devil's Island, Dam 2	16,678 30		16,678 30
Cairo protection	119,868 66		119,868 66
Alton Dike		33,324 70	33,324 70
Minton Point, primary hurdles Minton Point, secondary hurdles		33,436 37	33,436 37
Cape Girardeau, primary hurdles		10,093 59	10,093 59
Total	1,266,586 94	412,801 55	1,679,388 49

* NOTE.—Estimate of last year increased by amount previously expended between Dickey's Island and mouth of Ohio, and by amount allotted to Alton Harbor by act of August 2, 1882.

Property and material account.

Class of property.	Balance July 1, 1881.	Total debits.	Total credits.	Balance June 30, 1882.
Steamer Humphrey and expenses	$18,914 77	$29,554 80	$27,270 41	$21,199 16
Steamer Anita and expenses	4,851 97	10,613 88	12,555 63	2,910 22
Launch Hornet and expenses	105 71	1,587 31	1,586 46	106 56
Tug Mignon and expenses	4,077 72	1,049 40	1,049 40	4,077 72
Steamer Little Eagle, No. 2		7,707 84	7,707 84	
Barges	71,320 17	45,952 12	34,764 92	82,507 37
Pile-drivers	33,176 55	43,360 69	21,116 41	55,420 83
Quarters, shops, &c	15,445 05	32,702 48	13,974 05	34,173 48
Quarter-boats		9,849 49	2,323 51	7,525 98
Skiffs, &c	1,764 98	14,248 74	2,983 15	13,030 57
Tools and appliances	4,411 82	21,169 91	18,340 73	7,241 00
Hydraulic excavator		8,538 31	1,079 98	7,458 33
Ways for mattresses		6,961 17	1,250 08	5,711 09
Office furniture	441 95	592 25	120 84	913 36
Surveying instruments	1,114 95	636 91		1,751 86
Material, stone, Little Rock	1,581 99			1,581 99
Material, stone, Saint Louis		24,832 08	24,307 30	524 78
Material, piles, Saint Louis	1,121 68	84,726 30	78,136 64	7,711 34
Material, brush, Saint Louis	217 20	65,815 65	62,103 59	3,929 26
Material, stone, Minton Point		2,634 97	1,845 42	789 55
Material, piles, Minton Point		13,536 90	11,402 35	2,134 55
Material, brush, Minton Point		4,347 42	3,591 47	755 95
Material, miscellaneous	3,053 70	36,518 72	28,069 00	11,503 42
Subsistence		37,608 30	32,907 28	4,701 02
Boarding outfit		12,501 14	142 19	12,358 95
Total	161,600 21	517,046 78	388,628 65	290,018 34

A.

REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

SAINT LOUIS, MO., *August* 4, 1882.

SIR: I have the honor respectfully to submit my annual report upon works of which I have had supervision, under your direction, during the fiscal year ending June 30, 1882; and to transmit the annual reports by assistants charged with the duties of supervising construction at each of the localities at which works were constructed, each assistant reporting upon works at the locality at which he was stationed at the close of the year. They are:

1. Arsenal Island, by Mr. A. F. Freis, assistant engineer.
2. Horsetail Bar, by Mr. A. F. Freis, assistant engineer.
3. Twin Hollows, west side, by Mr. W. S. Mitchell, assistant engineer.
4. Carroll's Island, by Mr. C. V. Mersereau, assistant engineer.
5. Twin Hollows, east side, by Mr. C. V. Mersereau, assistant engineer.
6. Beard's Island, by Mr. J. W. Record, assistant engineer.
7. Jim Smith's, by Mr. John O. Holman, assistant engineer.
8. Engineer Depot, by Mr. C. L. Stevenson.

The report of each assistant being submitted upon the works at the locality at which he was charged with the duty of supervising construction at the close of the year, does not of itself indicate the connection that he had with the work. None of them were connected with these works prior to the 28th of last February, upon which day your order was issued making assignments of assistant engineers, as follows: Mr. W. S. Mitchell to be assistant engineer at Twin Hollows, west side; Mr. J. O. Holman to be assistant engineer at Twin Hollows, east side; Mr. J. W. Record to be assistant engineer at Beard's Island; Mr. A. F. Freis to be assistant engineer at Horsetail Bar, and Mr. C. V. Mersereau to be assistant engineer at Arsenal Island and Engineer Depot.

The following changes were made by your orders, dated May 4: Mr. C. V. Mersereau to Twin Hollows, east side; Mr. J. O. Holman to Jim Smith's, and Mr. A. F. Freis to Arsenal Island, in addition to the duties at Horsetail Bar; and on the same day Mr. C. L. Stevenson was assigned to duty as clerk, charged with the supervision of construction at the Engineer Depot.

Further reference will be made to each of these reports under the head of the locality of which it treats.

Each of the gentlemen whose reports are herewith transmitted are entitled to credit for faithful performance of duty and zealous devotion to his work.

I. ARSENAL ISLAND.

This work had for its object the maintenance of the normal width of the river, by preventing the erosion of the west bank of the island farther to the eastward than the line selected for the proposed east shore, and was begun in 1877, when a short section near the upper end was protected by a revetment of stone placed upon the bank after it was graded to a suitable slope to receive it. Upon this section the revetment extended up to the top of the bank.

The extension of the revetment down stream was delayed until the fall of 1879, while waiting for the erosion to proceed far enough to cut the proposed line of the east bank of the river.

This line having been reached upon a section of bank extending about 3,500 feet farther down stream, the revetment was extended to that distance, but only to a height of about 12 feet above extreme low-water, and was laid upon the slope of the bank graded only by the action of the current, but that was suitable for retaining stone, about two horizontal upon one perpendicular being the general inclination below the mean stage. The bank above that plane was not protected immediately because grading was necessary to prepare it to retain stone placed in revetment, and this work could be done by the current during higher stages of the river cheaper than by any other available means, the character of the bank being such that it could be safely left to be graded by such action. This grading and the erosion of the bank in front of the proposed shore line on the lower part of the island having been completed during the flood of the summer of 1881, the work of raising the revetment and extending the protection to the foot of the island was begun about the 1st of November, was suspended on the 17th of the same month, resumed on the 6th of March, and continued uninterruptedly until the close of the year.

The revetment begun in 1879 was completed by raising it to 16 feet above the plane of standard low water; the protection below that plane was extended down stream by placing 2,450 linear feet of mattress located as shown upon the map of the island, Plate II. This mattress has not been connected with the stone-work above, and a breach occurs in its continuity. The space between its upper end and the old work was left to await the result of hurdles built to re-establish the line of bank which had been cut away by an eddy started by a sunken barge lodging near shore opposite that point soon after the revetment of 1879 was constructed. The hurdles are rapidly accomplishing that object, leaving but little doubt that the new bank will be ready for protection during the next low water season.

The gap in the mattress was made by the loss of a section while under process of construction during the flood-stage at the close of the year. This will probably be replaced, the mattress extended to the foot of the island, and the revetment completed during the approaching season of low water.

In the protection of this island two forms of construction have been used; the first applied to that part of the protection which was begun prior to this year, and the second to new work. The first shown in cross-section in Fig. 1, Plate II, consists of a revetment of stone placed upon the surface below the plane of 16 feet above standard of low-water and of willows planted upon the slope above that plane. The second, shown in Fig. 2, Plate II, differs from this only in having a mattress of sufficient width to cover the slope between the plane of standard low-water and the bottom of the river, the slope above being treated in the same manner as in the first method.

The mattress used was about 40 feet wide with the tops of brush in the course normal to the current, extending about 10 feet farther into the stream. It was built in place and supported by lashing the grillage poles to the guide piles upon one side and by resting them upon small flats upon the other. It may be constructed in any desired lengths provided that the stages of the river should be favorable. The sections built have varied between 450 and 724 feet, although the river was high during nearly the entire time that the work was in progress, about equal to that of the tops of the guide piles, and frequently it ran full of drift-wood.

Reference is made to the accompanying report of Mr. A. F. Freis, assistant engineer, for further history of the works and quantities of material consumed therein.

The expenditures aggregate $14,513.88, distributed as shown in the following statement:

Material:		
Brush, secondary hurdles	$189 00	
Piling, secondary hurdles	463 45	
Labor, secondary hurdles	222 55	
Equipment, secondary hurdles	191 46	
		$1,066 46

Material:		
Brush, mattress	$2,336 72	
Stone, mattress	790 47	
Piling, mattress	660 92	
Miscellaneous, mattress	429 89	
Labor	2,305 70	
Equipment	508 39	
		$7,032 09
Material, stone, revetment	4,894 15	
Labor	845 73	
		5,739 88
Engineering and contingencies		675 45
		14,513 88

II. HORSETAIL BAR.

Operations at this locality were in progress at the beginning of the year, and were continued until the close with such interruptions only as were made necessary by unfavorable weather and stages of water.

The interruptions from these causes, however, were considerable. On account of the high stages of water only a small force could be economically employed during the first half of July, from the 1st of October until the close of the fall season, and during the month of June, while on account of unfavorable weather field-work was suspended from December 6 to March 20.

The year's operations began with a small party of laborers engaged in reconstructing the east primary hurdle line down stream from the point 200 feet below its intersection with secondary line No. 21, where that work was suspended during the preceding spring. When the river reached a stage favorable for enlarged operations, about the middle of July, that party was increased, and other parties were organized to resume work generally, repairing, reconstructing, and extending hurdles, which had been under process of construction, and beginning new lines. From the middle of July until the last of September the work was vigorously prosecuted, using to its full capacity the entire available plant, including barges, pile-drivers, small boats, and quarters; and during that time the east primary line had been completed a distance of 3,100 linear feet to its intersection with secondary line No. 29, and piles had been driven for its extension 1,000 feet farther to No. 30, when work upon it was suspended, about the 1st of October, while the work of repairing and extending secondary lines Nos. 27 and 29, and constructing No. 30, was continued until the 1st of November, when these lines had been completed, and were in good condition, with the exception that the large masses of drift-wood which had accumulated behind them had broken a small gap in each of the old channels near the primary line.

On account of the excessive depths due to the high stage of water, further work on these lines could not be economically done; and, therefore, the force was transferred to secondary line No. 18 to repair damages caused by the flood of the early summer, where it worked until the 6th of December.

Of secondary hurdles 4,984 linear feet were built; 1,111 feet were in line No. 18, 1,215 feet in line No. 27, 625 feet in line No. 29, and 2,033 feet in line No. 30.

On the west side the work of constructing the secondary lines which were left incomplete at the close of last year was resumed on the 11th, and that of the primary line was begun about the middle of July, and was continued until the last of September, when 5,390 linear feet of primary hurdles and of secondary hurdles 3,440 feet had been built, of which there were 174 feet in line No. 2, 266 feet in No. 3, 348 feet in No. 4, 509 feet in No. 5, 581 feet in No. 6, 740 feet in No. 7, 750 feet in No. 8, and 72 feet in No. 9.

The length of hurdles on both sides aggregates 8,490 linear feet of primary, of which the area is 164,780 square feet, showing that the average depth was about 19.5 feet, and of secondary hurdles the total length aggregates 8,424 feet, with an area of 177,467 square feet, giving 21 feet average depth.

The work at this point was resumed March 20, and was continued until the close of the year with a force which was increased and decreased as the stage of water became favorable or unfavorable for working.

During the spring season no new work was begun. The gap in secondary line No. 18 was closed, and the repairs of two small breaches which were made by the drift during the flood of June were begun.

The flood of last fall had damaged the primary line to such an extent that in places small channels formed, having sufficient velocity to erode the bed. The damage to the line extended from its head to secondary line No. 24, and consisted in tearing the curtains from the piles, displacing some braces and piles, except at two points, one between secondary lines Nos. 20 and 21, and the other between Nos. 22 and 23, at each of which the piles in both rows were destroyed or torn out of their places, making breaches through which the water passed with such velocity that it removed part of the material deposited during last year.

In repairing, gates were used to replace the destroyed curtains. These were made of plank with spaces between consecutive planks about equal to the width of the plank. In the breaches the bottom was protected by foot-mats extending well to the front of the line and short distances above and below the breach to cover the entire space affected.

The repairs were completed from the head of the line down to a point midway between secondary lines Nos. 21 and 22, and piles were driven in the breach below.

On the west side a portion of the primary line is incomplete. On part of this piles only have been driven. On another part the foot-mat has been placed, leaving only the matting to complete it. The high stage of water kept the piles submerged during the entire working season of the spring, so that this work could not be completed.

The work done during the spring season being added to that of the fall, makes the following totals for the year: of primary hurdles 9,690 linear feet, or 186,380 square feet, showing an average depth of 19 feet, which cost $5.65 per linear foot, or 29.4 cents per square foot; and secondary hurdles 8,774 linear feet, having an average depth of 21 feet, making the area 184,019 square feet, at cost of $4.34 per linear foot, or 20.7 cents per square foot.

The expenditures for labor and materials are shown in the following tabulated statement, of which the aggregate is $98,553.23, distributed as follows:

Material:		
Brush, primary hurdles	$7,939 30	
Stone, primary hurdles	3,770 92	
Piling, primary hurdles	23,400 10	
Miscellaneous, primary hurdles	4,649 83	
Labor, primary hurdles	9,288 01	
Equipment, primary hurdles	4,765 63	
Subsistence, primary hurdles	977 78	
		$54,791 5
Material:		
Brush, secondary hurdles	4,972 55	
Stone, secondary hurdles	1,196 79	
Piling, secondary hurdles	17,980 92	
Miscellaneous, secondary hurdles	2,242 90	
Labor, secondary hurdles	7,422 93	
Equipment, secondary hurdles	3,885 52	
Subsistence, secondary hurdles	404 70	
		38,106 3
Engineering and contingencies		5,655 3
		98,553 2

An experiment was made with the use of the water-jet in assisting to open channels through bars, the value of which is not confined to the particular locality.

Upon the approach of the low water stage, about the middle of September, the reef flattened out, lying from Dike No. 1 to the upper end of the Carroll's Island Bar, with nearly equal depth throughout its length, having, however, three slight depressions or channel-crossings, in each of which the depth was about 6 feet when the stage of 8½ feet was reached, which was but little greater than the depth upon its general crest. The upper one of these depressions was selected for the experiment, because its location was at the narrowest point of the bar and within the lines deemed most favorable for the permanent location of the improved channel, considered either in the interest of the navigation or of the permanency of the works.

The jet used was made by uniting the nozzles of the jets upon four pile-drivers to make them discharge, as nearly as practicable, in a single stream; each of these jets was supplied by a Worthington duplex pump with steam cylinders 7½ inches, water cylinders 4½ inches by 10 inches stroke, which could throw about 165 gallons per minute when running at the limit of safety, or with a piston velocity of about 100 feet per minute.

The drivers were firmly lashed together, and by means of three anchors, suitably placed, were drawn back and forth across the reef in the line selected for the channel.

The results were wonderful, the depth having been increased to 8½ feet with sufficient width for the ordinary purposes of navigation within twenty-four hours after the work was begun, and when only 10 hours of actual work had been done. The work was continued one week, at the end of which time 9 feet could be carried over the bar by the largest tows plying upon the river, and the channel became well defined by the line of maximum velocity passing through it.

While the result was valuable as an auxiliary measure in fixing the channel at this locality, it has a greater value in showing what may be accomplished by means of suitable water jets applied either as auxiliaries to works for permanent improvements, or independently to secure temporary improvement of navigation in advance of the permanent improvement.

Referring to the tracing of the map of this locality (Plate IV), upon which the curves of the stage of 12 feet above low-water at the beginning and close of the year are shown, a decided improvement is found to have been made in the trace of the channel and in the distribution of the deposits made within the inclosed areas on the east side, while upon the west side a large portion of the area to be reclaimed has been raised to the height of the adjoining bank.

The report showing details of construction and expenditure of material is submitted by Mr. A. F. Freis, assistant engineer, to which reference is made.

III.—TWIN HOLLOWS, WEST SIDE.

On account of delays experienced in securing suitable persons to board employés, preparations to begin work at this locality were not completed until about the 1st of October, which would otherwise have been done a month earlier. About that time the work at Horsetail Bar had progressed so far that a reduction of the force became necessary, and this was done by transferring a part of it with barges, pile-drivers, and quarters to this locality.

The primary line was located, its construction was begun at the nearest point to its upper end, at which the bed-rock was covered with sufficient sand to hold piles. This was found at a distance of about 500 feet from shore.

The line passed over a bar which would become dry at the stage of 9 feet on the Saint Louis gauge, central at the first angle counted from the upper end. The depth of water on this bar was not sufficient to float a pile-driver when work was begun, but the river began to rise soon after that, and the pile-drivers were dropped down to that bar to construct the line there while the depth of water was sufficient to float them, and the barges loaded with material. The rise continued until the river became bankfull, when the stage of 29.5 feet above extreme low water was reached about the 10th of December, and in consequence the depths and velocities along the shore increased to such dimensions that to make the connection would have been expensive, and on that account the work was deferred, with the hope that an opportunity to make it at comparatively small cost would be presented before the close of the season. The flood prevented this, however, although a single mattress was placed in the foundation of a hurdle dike intended to close just before the suspension of operations.

The work done during the first half year was constructing a detached section of the primary line, of which 2,375 feet were completed, and beginning a secondary line.

The results were remarkable, for, although the work was in an unfinished condition at the close of the season, large deposits had been made within the area that would be inclosed by the works when completed. A bar, whose crest became dry when the river fell to 22 feet above low water, extended nearly the whole length of the finished portion of the primary line, and was only about 2 feet lower as far as the piles had been driven.

Work was resumed on the 13th of March, and continued to the close of the year—at first with a small number of men, on account of the uncertainty of having favorable weather or stages of river during the early spring; but when the stage became favorable and the opening spring gave promise of weather suitable for full operations the working force was increased until about four hundred men were employed, which was maintained until about the 10th of May, when the river rose to the dimensions of a flood, causing a suspension of the work of constructing hurdles, and in consequence a reduction of the force to less than one hundred men, which continued work upon cribs to connect the piles of the primary and secondary hurdle lines with the shore.

Piles were driven for the extension of the primary line to a distance of 400 feet below its intersection with secondary line No. 4, or about 8,800 feet from its initial point on shore, and of this distance about 5,000 feet were completed, 2,300 feet additional had mattresses placed, while piles only were driven for about 1,500 feet.

Two secondary lines, Nos. 3 and 4, were completed each to a distance of about 900 feet from the primary line towards shore, and piles were driven and mattress placed for about 800 feet upon each of lines Nos. 1 and 2, and the braces were placed upon line No. 1, and work was suspended upon Nos. 1, 2, and 3, when too little sand was found on the bed-rock to hold piles, and upon No. 4 a little short of that point, leaving short gaps between the end of each and shore to be closed by cribs shown in plan, cross-section, and elevation, Plates VIII and IX, Figs. 1, 2, and 3, respectively. Of these, a section 240 feet long was built in slack water near shore above the head of work, and when completed it was floated into position by means of barges, to which it was lashed, and was placed by being loaded with a liberal supply of stone, after which the bottom in front of it was protected against possible scour by a revetment of the same material.

Two other sections were under process of construction at the close of the year, similar to that built, with this difference, however, that the cross-sections presented the figure of isosceles instead of right-angled triangles.

The efficiency of the crib was proven, standing uninjured the severe test to which it was subjected by the drift-wood brought in contact with it during the flood of June, furnishing a cheap means of connecting both the primary and secondary hurdles with the rocky shore; the cost of which in the primary line would otherwise have been excessive, for on account of the great depths large quantities of material would necessarily have been expended in constructing any solid structure, and the experiment made with curtains showed that permeable structures held in position by anchors were not adapted for use in the swift current and upon the smooth sandy bottom found at high stages near the shore at that locality.

Hurdles continued to be constructed after the improved form introduced during the preceding year at Horsetail Bar, bracing the piles and protecting the bottom, as shown in the report of that year. An improvement was made in the method of bracing piles by substituting a clevis, Plate VII, designed by Mr. W. S. Mitchell, for ring-bolts in holding the heels of braces in place, and the protection of the bottom by mattresses was extended to all hurdles constructed. The width of mattresses used in primary was usually twice that of secondary lines.

The strength of the hurdles has not been thus increased without a corresponding increase in the cost per linear and square unit, the extent of which cannot be determined at this time, because much of the work is unfinished; however, the increased strength justified spacing the secondary lines at 2,000 feet instead of 400 feet, and this fully compensates by reducing the number of units.

Large deposits of material have been made within the area intended to be reclaimed, and the tow-head lying to the eastward of the primary line within the space allotted to the channel has disappeared; but although these results should be satisfactory, they would doubtless have been greater had the primary line been connected with shore.

Reference is made to the report of Mr. W. S. Mitchell, resident engineer, submitted herewith, for further details.

The expenditures aggregate $103,500.25, of which the distribution is shown in the following statement:

Material:		
Brush, primary hurdles	$9,336 50	
Stone, primary hurdles	4,770 03	
Piling, primary hurdles	21,122 76	
Miscellaneous, primary hurdles	3,591 63	
Labor, primary hurdles	13,439 46	
Equipment, primary hurdles	10,681 59	
Subsistence, primary hurdles	10,142 33	
		$73,0[illegible]
Material:		
Brush, secondary hurdles	2,071 00	
Stone, secondary hurdles	662 45	
Piling, secondary hurdles	7,410 72	
Miscellaneous, secondary hurdles	954 69	
Labor, secondary hurdles	3,427 75	
Equipment, secondary hurdles	5,128 22	
Subsistence, secondary hurdles	5,050 18	
		24,705 [illegible]
Engineering and contingencies		5,710 [illegible]
		103,500 [illegible]

IV.—CARROLL'S ISLAND.

The protection was begun about the 1st of October, when a mattress-barge, with mooring-barge, was placed in position about 1,700 feet above the foot of the island. The protection contemplated placing a mattress 120 feet wide below the plane of standard low-water, with a revetment of stone up to the plane of 16 feet above that stage, and willows planted from the upper edge of the revetment to the top of the bank. Of these, only the mattress was placed, subsequent changes in currents having stopped the erosion and started a deposit outside of the work, making its immediate completion not only unnecessary, but impracticable, by building a large bar during the flood which set in about that time, connecting with the west side of the island, which became dry at several points before the water had receded below the plane of 20 feet above low water, or at 4 feet above the upper edge of the proposed revetment. This bar was not less than 300 feet wide opposite the head of the protection.

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* See Plate XIV.

The mattress was built in one section, 1,695 feet long, by sinking only a part of that constructed until the whole was completed.

Being the first mattress of the kind built in this vicinity, many details connected with its construction had to be learned experimentally, which, with unfavorable weather and swift currents, caused the work to progress slowly during the season. Still the rate of construction was increased to 100 feet per day before the mattress was finished.

No other work in connection with this protection has been done; and although future changes may necessitate its completion by revetting the middle and planting the upper zones, respectively, the tendencies of the river, with the present trace of its channel, indicate that none will be needed. This work having been constructed in such close connection with Twin Hollows, east side, that the data showing expenditures of material appear only as items in the records of that work.

Mr. C. V. Mersereau, assistant engineer, who has compiled the expenditures of labor and material from those records, submits the report, to which reference is made for further details, and the quantities of material used. The exact location of the work is shown upon the accompanying tracing of the map of that locality, Plate X.

Expenditures for labor and material aggregate $12,038.69, distributed as shown in the following statement:

146 piles	$934 40
1,467.9 cords of brush	3,816 54
600 cubic yards of stone	762 00
Rope, wire, &c	898 35
Labor	3,593 40
Equipment	1,474 65
	11,479 34
Engineering and contingencies	559 35
	12,038 69

V.—TWIN HOLLOWS, EAST SIDE.

This work has for its object the protection of the east bank of the river from the foot of Carroll's Island to the head of Beard's Island, or as far in that direction as may be found necessary, a distance that has been increasing, owing to the tendency of erosive action to move downstream. It was begun October 26, and continued uninterruptedly until December 10, and from the 17th until January 8, when it was suspended on account of unfavorable weather, to be resumed on the 21st of March, after which it was continued until the close of the year without interruption. During the year 5,925 feet of the zone below standard low-water were protected by a mattress 120 feet wide, made of sections in such lengths as were found practicable to be built under conditions due to the variable weather, stages of river, velocity and direction of current; and of the middle zone 2,350 feet were protected by a revetment, of which 1,000 feet were made of stone placed upon a loose brush mattress, and 1,350 feet were made entirely of stone. Of these 1,493 feet of the mattress and 840 feet of revetment were built during the first half of the year. The upper end of the mattress was pushed ashore by drift-wood driven by the swift currents accompanying the flood of November, and covered 150 linear feet of the middle zone.

Early in the spring season the use of this shore mat was restricted to localities at which the inner edge of the mattress lay outside of the curve of standard low-water, on account of the line having been moved by erosion after the guide-piles were driven.

During the second half of the year two sections of mattress were built and placed, one 3,800 feet long, of which 3,100 feet were placed in good shape; the remainder was damaged by the current while sinking to such extent that it was not an efficient protection. Another section was placed to cover that space. The other, 1,325 feet long, was successfully placed by means of lines attached to barges anchored along its length, but independently of it, to hold it out from shore and prevent the doubling of the outside edge under the mattress while in process of sinking, and a section of 964 feet long was afloat at the close of the year.

Many difficulties were encountered in placing the mattress in the deep, swift water found during the prevalence of the spring floods.

This form of mattress being very flexible, skillful handling was necessary to prevent folding it by the current carrying the outside edge under when that edge was sunk in advance. The difficulty became so great when the angle between the axis of the current and bank was greatest that the mattress needed additional strength to prevent breaking while sinking. This was secured by placing a grillage of poles under it, spaced to make meshes about 8 feet by 10 feet, the longer sides being parallel to the direction of the length of the mattress.

The mattress arrested the erosion at once. The upper portion of the bank continued to be graded by the current to a suitable slope to retain a stone revetment, but that part covered by the mattress was not disturbed, although the depth of the water ranged between 40 and 60 feet along its outside edge, and impinged with excessive velocity upon the bank, between which and the axis of the current the angle was about 40° Owing to the progression downstream of that axis the greatest impact passed over the whole length of the protected bank during the year.

On account of the high stages of the river but little use could be made of the hydraulic excavator in grading, only 2,100 linear feet having been graded by it. This afforded a sufficient trial, however, to show that it would do the work rapidly and well at low stages, when the part to be graded would be above the surface of the water.

The efficiency of the form of bank protection has been severely tested here with satisfactory results, immediately arresting the erosion of the bank, which was caving rapidly under the attacks of swift currents, due to flood stages, impinging at angles ranging from 30° to 45°, and scouring the bed at the foot of the slope, which was steeper than two upon one, to depths ranging from 40 to 60 feet at prevailing stages, or from 20 to 30 feet below the plane of low water.

Another severe and important test was made in constructing and placing the low-water mattress under nearly or quite all of the adverse circumstances that may reasonably be expected to be encountered throughout an entire working season.

The river was in flood when the work was begun in October, and continued so until December; again during the spring it was continuously above the mean stage, with swift currents, driving bodies of drift-wood to accumulate upon or under the mattress, or under and against the mooring-barge, bringing excessive strain upon the lines, mattress, and the barge.

This test has shown conclusively that it may be made continuous or in sections of any desired length under ordinary circumstances, with the river below the mean stage and stationary or falling; and that with the unfavorable circumstances of high and rising river and swift currents bringing masses of drift-wood in contact with it, sections may be kept afloat until any desired length up to 1,500 feet can be built, and such sections can be readily and safely placed in position by taking proper precautions in handling them.

The fact stated in another paragraph that the low water mattress, when placed, arrested the caving of the bank immediately, in connection with the further fact that no erosion has started upon any part of it covered by the low-water mattress, is important, because it proves that at most localities upon this section of the river the portion of the bank above standard low water may be left unprotected during a period of considerable length with safety, to be graded in part at least by currents of mean and higher stages.

Several small eddies were started in advance of the placing of the mattress, each excavating a small semicircular bay before its action could be arrested, which was done by constructing short hurdles.

Reference is made for further details of construction and quantities of material used to the report of Mr. C. V. Mersereau, assistant engineer, submitted herewith.

The expenditures made on account of works at the locality aggregate $72,696.63, distributed as shown in the following statement:

Material:		
Brush, mattress	$20,230 04	
Stone, mattress	3,364 85	
Piling, mattress	3,804 68	
Miscellaneous, mattress	3,008 18	
Labor, mattress	14,356 89	
Equipment, mattress	6,087 56	
Subsistence, mattress	7 496 68	
		$58,348 88
Material:		
Brush, revetment	3,189 25	
Stone, revetment	1,945 49	
Miscellaneous, revetment	97 05	
Labor, revetment	1,025 87	
Equipment, revetment	446 74	
Subsistence, revetment	625 14	
		7,329 54
Labor, excavation	358 67	
Equipment, excavation	1,079 98	
		1,438 65
Engineering and contingencies		5,579 56
		72 696 63

VI. BEARD'S ISLAND.

The protection of this island was begun about the last of March, and was continued until the close of the year. During that period 3,850 feet of mattress were built and placed to protect the lower zone from the head of the island down stream, a distance of 3,550 feet, 300 feet having been expended in repairing a breach in the original mattress.

The first section of mattress was 3,250 feet long, of which 2,600 feet were placed without a single breach, kink, or defect of any kind, but at that point the outside edge of the mattress was torn, and by stretching down stream left a triangular-shaped area unprotected, necessitating the replacing of an extra section of mattress to protect it.

In a comparison of long mattresses this would rank second, whether its total length constructed or only that successfully placed should be measured, being exceeded only by the longest one placed at Twin Hollows, east side.

From the head of the island a distance of 2,000 feet down stream the work of constructing and placing the mattress was comparatively easy; the depths of water and the velocities of the current near shore were not excessive at any point within that space, while swifter currents farther out in the stream tended to throw the drift-wood and other floating bodies away from the shore impinging upon the bank farther down stream and presenting no cause of delay in the progress of the work until that distance had been passed in placing the mattress. At that point unfavorable changes in depths of water, velocity, and relative direction of the current occurred.

The depth, which had been moderate, increased abruptly to 40 feet along the outside of the mattress, with an increase in velocity due to that change, and the direction relative to that of the axis of the mattress was unfavorably affected by a sharp deflection of the bank through an angle of about 25°. The remainder of the mattress was placed with considerable difficulty, on account of the tendency of the current to break it by driving it against the guide piles or by doubling the outside edge under or over when its whole width did not sink together; but the section was placed with only the single break mentioned in the preceding paragraph.

The next section of mattress was started at station 32 + 50, where the velocity, direction, and depth of the current were still unfavorable. Large quantities of drift-wood were brought by the river and driven under the mooring-barge, accumulating in such masses that a line attached to the stern of the barge parted, permitting the barge to swing in towards shore, carrying the mattress and the barge upon which it was built so hard against the piles that the continuation of the construction became impracticable, and the section was launched when only 360 feet were built. This section was successfully placed, being guided to its position by lines attached to it and to barges anchored in the stream outside of and entirely independent of it. These lines, by being attached to the timber-heads and kevils upon the farther side of a barge and passing under it, did not immediatly interfere with the sinking of the mattress, but held it away from shore, necessitating the paying out of the lines only after the mattress had been sufficiently loaded and had advanced towards its final resting place on the bottom.

The revetment of the bank was begun on the 18th of May, and about 1,600 linear feet were finished—the progress made keeping pace with the receipt of stone, which was retarded by the high stage of the river. Grading for the revetment was done by the current cutting the bank above the mattress after it had been placed, while the erosion below that plane was stopped. The work of grading was well done, the slope being reasonably evenly dressed and flat enough to retain stone.

This bank had been yielding rapidly to the attacks of the current before the mattress was placed, a strip of land from 600 to 800 feet wide, running the entire length of the island, having been cut away since the fall of 1880; and the erosion having progressed rapidly up to the time that the mattress was placed, shows the form of protection is efficient.

The small water-way passing around the head of the island was closed by a hurdle about 1,000 feet long, constructed in the usual form for secondary lines, except that the foot mattress extended only 450 feet from the island, on account of the small velocity of the current from that distance to its upper end.

The bar was built up to the top of the hurdle soon after it was completed, its crest being about 28 feet above low water, or within 2 feet of the general height of the bank, and its width is about equal to that of the head of the island.

Reference is made to the report of Mr. J. W. Record, assistant engineer, for further details.

The expenditures aggregate $35,614.53, distributed as shown in the following statement:

Material:	
Brush, mattress	$10,354 23
Stone, mattress	1,240 20
Piling, mattress	1,954 55
Miscellaneous, mattress	659 69
Labor, mattress	6,101 15

quipment, mattress	$2,007 76	
Subsistence, mattress	3,064 20	
		$25,381 78
Labor, excavation	10 15	
		10 15
Material:		
Stone, revetment	1,190 46	
Miscellaneous, revetment	1 70	
Labor, revetment	349 56	
Subsistence, revetment	63 13	
		1,604 85
Material:		
Brush, hurdles	702 00	
Stone, hurdles	122 79	
Piling, hurdles	1,325 87	
Miscellaneous, hurdles	44 04	
Labor, hurdles	394 93	
Equipment, hurdles	1,222 19	
Subsistence, hurdles	2,991 54	
		6,803 36
Engineering and contingencies		1,814 39
		35,614 53

VII. JIM SMITH'S.

This work was begun May 23, and, although the river was high from that date until the close of the year, considerable progress was made upon the construction of the primary line, in which 426 piles were driven, extending from shore at its head 1,000 feet down stream; of that 800 feet of mattress, 50 feet wide, were placed, and 500 feet were hurdled, which was done by wattling to the depths to which that form of construction could be economically used, and in greater depths a wattled curtain, shown in Plate XIII, was placed in the base, of which the poles extended to the surface of the water, to be incorporated in the wattling upon the piles; of this curtain 250 linear feet were placed.

The river was in flood during the entire time that this work was in progress, and much time was consumed in preliminaries of erecting quarters and making surveys that were needed in locating the line of the primary hurdle, in accordance with its representation on the map, and the progress made in constructing the hurdles was small compared with that which could have been made under favorable circumstances, on account of the swift currents, great depths, and the large masses of drift-wood which the high and rising river brought to oppose the progress of the workmen.

The results, however, fully compensated for expenditure, as shown by the deposits that were made about the close of the year, which raised a bar equal in width to the length of completed hurdle, and in height to that of the wattling immediately in rear of the line, thence dipping down stream it may be traced by the shoaling to the lower end of the locality.

The report of Mr. John O. Holman, assistant engineer, is submitted herewith, to which reference is made for further details of construction and quantities of material expended.

The expenditures aggregate $11,068.37, distributed as shown in the following statement:

Material:		
Brush, primary hurdles	$513 00	
Stone, primary hurdles	349 70	
Piling, primary hurdles	2,059 33	
Miscellaneous, primary hurdles	139 64	
Labor, primary hurdles	1,413 91	
Equipment, primary hurdles	1,973 11	
Subsistence, primary hurdles	2,513 40	
		$8,962 09
Material:		
Brush, secondary hurdles	67 50	
Piling, secondary hurdles	76 57	
Miscellaneous, secondary hurdles	27 64	
Labor, secondary hurdles	24 08	
Equipment, secondary hurdles	132 03	
Subsistence, secondary hurdles	279 27	
		607 09
Engineering and contingencies		1,499 19
		11,068 37

VIII. ENGINEER DEPOT.

During the first half of the year the work of constructing and repairing barges, barge-flats, pile-drivers, quarter-boats, portable shanties for quarters, and small boats appertaining to the equipment, not only for these works but for general use upon the river between the Illinois and Ohio rivers, was done at the foot of Marine avenue. The depot of supplies of rope, iron, spikes, nails, bolts, and other items belonging to the class known as miscellaneous material, was also established there in rude shanties too small to furnish protection to the stock of material and subsistence stores necessary to be carried. These shanties were built of common boards, and covered with the same, upon ground that the river had recently made by depositing a portion of its sediment, and which its erosive currents were rapidly removing towards the sea.

A depot was established on the east side of the railroad in front of the Saint Louis Arsenal, consisting of two store-rooms—one for material, the other for subsistence—buildings for carpenter and blacksmith shops, oakum and oil rooms, and offices for clerks in charge of subsistence, of working parties, and material at the depot. Of these the blacksmith shop and oakum room were moved from Marine avenue; the others were constructed from new material.

The work was begun January 21, and the first stores were received there about the 1st of March, when the old stand at the foot of Marine avenue was abandoned, with the exception that repairs of barges were continued there a short time after that, until some dangerous parts of old wrecks could be removed from the front of the depot.

The equipment available for works between the Illinois and Ohio rivers was increased during the year by the addition of eleven pile-drivers, one hydraulic excavator, two mattress-barges, thirty-seven portable shanties for quarters, and eighty small flats constructed, and twenty-nine barge-flats altered from coal barges, of which only two were purchased this year, the others having been on hand from the purchase of the preceding year; forty-two yawls and eighty-two skiffs purchased, while the steamers A. A. Humphreys, Anita, steam-launch Hornet, pile-driver No. 2, and barges Nos. 12, 13, 14, 17, 18, 19, and 20 received extensive repairs, which, upon being added to that on hand, made the equipment and quarters available for use in connection with these works sufficient to accommodate a force of about 1,500 laborers.

Reference is made to the report of Mr. C. L. Stevenson, clerk in charge of material and working parties, herewith submitted, for further details of construction.

The expenditures on account of the operations in connection with the depot and equipment aggregate $140,134.11, distributed as shown in the following statement:

Humphreys	$4,408 52
Anita	809 66
Hornet	286 92
Barges	87,038 44
Pile-drivers	29,461 68
Hydraulic excavator	8,538 31
Ways for mattresses	6,461 17
Quarter-boats, quarters, shops, &c	31,994 92
Skiff, &c	14,119 88
Tools and appliances	7,014 61
Total	140,134 11

IX. PROCURING MATERIALS.

Procuring the materials, brush, stone, and piles constituted a separate division of the work, in which nearly the whole time of the steamer A. A. Humphreys, ten model barges, and sixteen barge-flats was consumed.

Brush was procured by hired labor, a royalty being paid to the owners for permission to cut and remove it.

During the first half of the year a party was organized under an overseer and kept at work on the islands and bars between the head of Fish Bend and Jones' Point, until about the middle of November, when it suspended work on account of high-water. It was reorganized and set at work in the Missouri River about the 1st of March.

Two other parties were organized and set at work in the Mississippi River, one about the 10th of March, which worked in the vicinity of Fish Bend, the other about the last of April and worked in the vicinity of Cabaret and Wilson's Islands. The three parties consisted in the aggregate of about three hundred men. Those in the Mississippi River continued at work until June 1, when they were disbanded on account of the lowlands from which they were procuring brush having been overflowed. That in the Missouri River, having higher grounds, worked there until the 23d of June, when the brush that was available at high stages of water having been procured, it was transferred to Jones' Point, Mississippi River, where it remained until the close of the year, procuring poles and such brush as was available.

Of the 25,000 cords procured 14,500 cords came from localities on the Mississippi River, distributed as follows: Liberty Island and Towhead, 6,800 cords; Fish Bend and vicinity, 5,000 cords; Cabaret Island and vicinity, 1,700; and from the immediate vicinity of the works, 1,500 cords; and from the Missouri River, 10,000 cords; distributed as follows: Little's Island, 2,100; Hog Island, 4,900 cords; and Green Island, 3,000 cords.

The average distance towed is estimated to be equivalent to 40 miles of upstream towage; and to reach navigable water the average haul is estimated at about 1 mile. These distances are greater than brush has been towed or hauled during any previous year, but not greater than may be expected in the immediate future. They are the variables of the elements which make up the cost of procuring this material. Cutting and loading can be done with a nearly constant expenditure of labor and with only such variation in cost as may be due to that of the rate of wages.

Pile timber was procured by purchase in open market; 11,579 sticks, measuring 354,571 linear feet, were delivered in rafts at the works, and 5,845 sticks, measuring 204,707 linear feet, were delivered upon barges belonging to the United States at landings between Turkey Island and Big Eddy, the average distance of upstream towage being about 65 miles.

Of the stone used in the works, 7,487.6 cubic yards were procured at Chester, Ill., and 15,733.90 cubic yards were procured from quarries near the works located at Bushberg, Kimmswick, and this city, by purchase in open market, delivered upon barges belonging to the United States, and was towed to the different localities at which it was used, an average distance of 30 miles.

Miscellaneous material was procured by purchase in open market in large quantities, to secure the advantages of wholesale prices, and to keep a supply in stock for distribution among the works. This item includes lumber, bolts, iron, spikes, nails, rope, and yarn. The materials named were kept constantly on hand, and in sufficient quantities to furnish each of the works with an ample supply.

In addition to the towing needed in procuring material used, the steamer A. A. Humphreys has handled all barges, pile-drivers, quarter-boats; transported all miscellaneous material, subsistence stores, and ice needed in connection with the works, and still it has not been at all pressed, the distribution of its service showing that it was idle about 7 per cent. of the entire time that it could have worked, exclusive of the thirty-six hours per week, from Saturday night to Monday morning, allotted to cleaning boilers, making minor repairs, and rest.

The comparative ease with which the steamer accomplished the work devolving upon it is due to a combination of several causes, of which the following are prominent: First, it was furnished with two electric lights, one a reflector revolving to illuminate distant objects, and to be used in making landings at the works and running close dangerous reaches of river during dark nights, and the other to illuminate the forecastle for use in making up tows, coaling, and handling material and stores transported at night, thus preventing the interference of darkness with the length of a working day. Second, the loss of time, in making landings for the purpose of learning the wants of assistants and other persons having charge of working parties served by it, was reduced to a minimum by the use of a code of signals, by many of which the service desired could be communicated at a distance, enabling the boat to proceed directly with the work instead of landing to receive instructions. Third, the telephone connecting each of the works, the depot and office, was freely used during the last two months of the year, in communicating with persons in charge of construction, to learn the wants of each locality, in directing the movements of the boat, and in having supplies of material, subsistence, fuel, and ice delivered at the depot or other convenient points, and contributed largely to securing prompt service with the least possible expenditure of work.

X. WEATHER AND RIVER STAGES.

The year was not a favorable one either for procuring material or for construction. The river, which was 23 feet above low-water on the 1st of July, declined slowly until about the 1st of September, when the gauge indicated 8¼ feet above the same plane. It then rose to the 20-foot stage by the middle of October. This flood continued until the 29½-foot stage was reached, on the 20th of November, and then slowly receded to 17 feet above low water, which was the stage at the end of December.

The flood retarded progress in all field operations by overflowing the low grounds which produced the willows and other saplings suitable for brush. On this account the season was permanently closed at some localities considerably earlier than was made necessary by the weather. Another result of the prevailing high stage was the swift current and deep water at the works, bringing immense masses of drift-wood, parts of which became entangled in the piling of unfinished hurdles, collected under mattresses, or were driven with such force against barges and other vessels of the equipment that they were in constant danger of being sunk by detached logs or grounded by the accumulations under them. The first half of the year was not made unfavorable by floods alone, the weather was excessively hot during the months of July and August, after which heavy rains followed, continuing until the 10th of December or until the season had closed at Arsenal Island, Horsetail Bar, and Twin Hollows, west side.

About the last of February, when preparations to resume work were nearly completed, another flood came suddenly, beginning on Monday the 20th, after about 6.75 inches of rainfall during Saturday night and Sunday. The river rose 0.8 of a foot in twenty-four hours ending at 1 p. m. Sunday, 8.75 feet from that to the same hour Monday, and 7.95 feet additional before Tuesday the 21st, at the same hour. During part of Monday it rose at the rate of 12 inches per hour.

The flood reached its extreme height Wednesday the 22d, when the stage of the river was 28.25 feet above low water on the Walnut-street gauge, Saint Louis. It did not seriously injure the works, but by overflowing the low lands upon which willows suitable for brush grow, delayed the resumption of active field operations until the ground became firm enough to sustain teams after the recession of the flood, which was about the 3d of March, after which the progress made with all of the works was uninterrupted until about the last of May, when the river again left its banks in the low lands and retarded progress at all of the works by bringing large masses of driftwood to accumulate against piles while the works were in an unfinished state, by submerging piles that had been driven for hurdles, by causing swifter currents in which barges, pile-drivers, and other vessels used in connection with the work had to be handled, and by reducing the available supply of stone, brush, and piles, overflowing a portion of the loading room at the quarries from which stone was procured and the ground upon which brush and piles grow.

XI. QUARTERING AND SUBSISTING LABORERS.

Prior to this year, when operations were upon the basis of smaller allotments to be expended, parties of laborers away from Saint Louis were subsisted by the United States furnishing suitable boats, shanties, or tents for quarters, and making arrangements with suitable persons to furnish the necessary outfit, and board employés, furnishing substantial fare at agreed rates, to be collected from such employé at the pay table. That system worked satisfactorily while the number of employés remained small, say three hundred or less laborers; suitable persons to board that number were easily secured; but when the demand was suddenly quadrupled, by the enlarged field of operations inaugurated at the beginning of this year, it could not be supplied, and on that account the progress made during the first half of the year was less than it otherwise would have been. For the reasons stated, that system was abandoned at the close of the first half year; another was formulated during the winter and introduced at the resumption of operations in the spring, in which the United States furnishes the outfit complete, and subsists the employés at all localities at which they could not secure other satisfactory arrangements, making suitable reduction in their rate of compensation to cover extra expenses incurred on that account. Introduced about the 1st of March, it was in operation about four months of the year, a period of sufficient length to thoroughly test its adaptability to the wants in connection with operations for improving the river based upon large appropriations.

The dissatisfaction among employés on account of subsistence has been less than usual since this system was introduced, although that did not receive consideration in determining the change. The great benefit that was hoped would be derived from the new system of subsisting lies in the complete control over the strength and movements of working parties that it gives to the engineer. The hope that this control would be attained induced the change of systems, and that hope has been fully realized.

XII. COMMUNICATIONS.

Prior to the 1st of May, communications between the office, the depot, and the works were made through the steamer A. A. Humphreys, using, in cases of emergency, the local trains on the Iron Mountain and Southern Railway. These trains not carrying mail, they were necessarily by messenger, the expense of which was one of the least objections to the method; but the delays in learning and supplying the wants at the works, necessarily incident to these slow methods are of much greater importance.

A telephone line was established between the United States Engineer Office, No. 404 Market street, Saint Louis, and the works at Twin Hollows, west side, with intermediate stations at the supply depot and Horsetail Bar. This line has since been extended to the mouth of the Meramec River. This brought the depot and works located upon the west bank of the river into direct communication with the office, and each with the others, while those upon the east side of the river could readily send messages by small boat to the nearest station, or, when important, the resident engineer could come to the nearest station for personal interview.

The telephone was freely used from the date upon which it was opened by all who were charged with supervision of construction in reporting progress made and difficulties encountered, asking advice, making requisitions for material and subsistence, employing laborers and others, and in reporting every matter of importance relating to their respective works; and it was also to a large extent the means used in directing movements relating to these works, based upon full information received through the same means.

The cash value of the telephone can scarcely be estimated, because the sum of the savings due to its use cannot be converted into a cash equivalent; however, it helped to reduce to a minimum the distances that the steamer had to run in delivering material and other service required, and this is only one of many items which could be enumerated. Broken machinery has been repaired, making requisition through the telephone for the parts needed to replace those broken; forms of construction have been sent, discussed, and modified in accordance with necessities; in particular instances lines of hurdles have been located after full discussion of the merits of several preliminary ones examined; raftsmen, when arriving out of time, rely upon this source for instructions relating to the delivery of piles; the details of expenditure, of labor, and material for insertion in weekly reports have been made and checked. This enumeration is incomplete, but is sufficient to show the value of the telephone for use in connection with the supervision of the works.

In this connection the small boats, including skiffs, yawls, and flats, have been of great service in delivering promptly small quantities of material, subsistence, tools, and parts of machinery, for which requisition had been made through the telephone, which otherwise would have been delayed by waiting for the steamer.

The works being situated below the supply depot, such delivery could be readily made, and the small boats were returned by the steamer, while the oarsmen returned by train, when the time lost in waiting for the boat would be worth more than the cost of a ticket by rail.

Very respectfully, your obedient servant,

D. M. CURRIE,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

B.

ARSENAL ISLAND.

REPORT OF MR. A. F. FREIS, ASSISTANT ENGINEER.

ST. LOUIS, MO., *July* 22, 1882.

MAJOR: I have the honor to submit herewith a report of the operations of the works at Arsenal Island for the fiscal year ending June 30, 1882.

ARSENAL ISLAND PROTECTION.

The work of completing the unfinished portion of the revetment at Arsenal Island was begun about the 1st of November, in obedience to instructions contained in your letter, of which the following is a copy:

"ST. LOUIS, MO., *September* 28, 1881.

"SIR: It will be necessary, before the close of the present working season, to complete that portion of the Arsenal Island revetment which was begun last year and left unfinished.

"You will please cover with riprap the upper part of the bank to a height of 20 feet above low water of 1863, procuring the stone as soon and as rapidly as convenient from the Southern Illinois penitentiary at Chester.

"You are requested also to ascertain whether the river bank below the old work has receded far enough to justify its continuation downstream, and report the results of your observations.

"Very respectfully, your obedient servant,

"O. H. ERNST,
"*Captain of Engineers.*

"Mr. D. M. CURRIE,
"*Assistant Engineer.*"

Owing to the demand for stone at the quarry, it could not be secured in quantities sufficient to justify beginning this work, after supplying the other localities in this vicinity, until about the 1st of November, when, as several barge loads had been secured, work was begun at the lower end of that portion of the revetment that extended to the top of the bank. The stage of the river was then about 23¼ feet on the Walnut-street gauge at Saint Louis, or 3¼ feet above the plane to which the upper edge of the revetment was to be extended, and, in consequence, the work could not be finished; but by constant use of the sounding-rod, the riprap was distributed very nearly in equal thickness over the zone between the upper edge of the old revetment, which was found at about the 10-foot stage, and the plane 20 feet above low water.

The work was continued until the 17th day of November, or fourteen days after it was begun, when, on account of the high water, it was suspended to await a more favorable stage, and as the general suspension of field operations followed soon after, this became final for the season. During the two weeks that work was in progress, 1,400 linear feet of the revetment were raised to the height designated in the letter of instructions, but the stone may need some redistribution to complete the work. The points are designated on the tracing by the letters *a b*, Plate II. This leaves 2,100 linear feet unfinished of the 3,500 begun in 1879.

The survey of the island, to determine whether the river bank below the old revetment has receeded far enough to justify the continuation of the work downstream, was made by Mr. Wm. S. Mitchell, assistant engineer, from which the present location of the bank was determined, as shown upon the tracing.

Upon comparing the proposed shore line below the revetment with the bank, as shown on the tracing, it is found to fall on the outside for about one-half the distance, and for the remainder of the way it runs a few feet inside of the bank, showing it has receded far enough to justify the continuation of the work.

The work of completing the remaining 2,100 linear feet of partial revetment was resumed on March 6, with a small force of men, and continued until May 6, when it was completed; having been carried to a height corresponding to a 20-foot stage, *b c* representing the points on the tracing, thus making a total of 4,200 linear feet of revetment placed upon the island.

An eddy which was eroding the bank to a great extent having formed at the lower end of the revetment, a series of cross-hurdles were placed to destroy the action of it. There were two lines placed at first, when it was found that the piles had deflected the eddy farther down stream, and that it was eroding the bank back of those lines; a third line was then determined upon, whose shore end would be such a distance down stream as to be outside of all action of it, and whose outer end would cut the eddy when it made its turn towards the shore. After driving this line and placing wattling upon the three it was found to have effectually broken the current, and a deposit commenced to form at once. The work of constructing these lines of hurdles commenced May 6 and continued until May 17, when they were completed; the aggregate linear feet of wattling contained in the three lines being 325; the greatest depth of water found at the end of the lines during construction being 36 feet. The depth found at the same place at the end of the fiscal year being 24 feet, the soundings having been reduced to the same stage, soundings taken at other points in the line show a corresponding deposit.

The driver proceeded on May 15 to drive a line of guide-piles to assist in the construction of a mat, the piles being driven 15 feet between centers and at such a distance from shore as to allow the placing of a foundation mat 40 feet in width, and whose inner edge when sunk would be in standard low water.

This work continued without interruption, with an increased force from May 15 until the end of the fiscal year, when there had been 2,800 linear feet of mattress constructed, 2,450 linear feet of which was placed on the bottom in good condition, the remaining 350 feet being lost through the giving way of the piles, which allowed the current to catch the mat and tear it loose.

The points are represented on Plate II by the letters *a*, *b*, *c*, and *d*.

This mat was constructed directly on the water, the outer edge of it having been lashed up to the line of guide piles about 1 foot from the surface so as to prevent the current from catching it, while the inner edge was allowed to rest on the water. It is composed of two layers of brush placed upon a frame grillage, composed of continuous poles laid 6 feet apart and running the length of the section, held by cross-pieces at intervals of 6 feet. Upon this grillage a layer of brush is placed at right angles to the current, then a second layer is placed on top of this parallel to the current. Upon top of this layer poles are placed directly over and parallel to the cross-pieces of the frame and the whole bound firmly together. There were also three lines of wire placed the length of each section of the mat, a round turn having been taken around each cross-piece of the frame. The mat was built in sections varying between 450 and 724 linear feet.

After completing this mat the bank will be protected with riprap, starting from the inner edge of the mat and extending up to a 20-foot stage.

Cross-sections of the two different features of the revetment are shown on Plate II, Figs. 1 and 2.

The following statement shows the number of linear and square feet of revetment and mat, constructed at Arsenal Island during the fiscal year ending June 30, 1882:

Three thousand five hundred linear feet of revetment of about 40 feet in width, or 140,000 square feet.

Two thousand eight hundred linear feet of foundation mat about 40 feet in width, or 112,000 square feet.

MATERIAL USED IN CONSTRUCTION.

Stone	cubic yards..	5,571.5
Brush	cords..	935.6
Piles (301 piles)	feet..	10,682
Wire No. 12	pounds..	211
Rope	do....	5,065
Spikes	do....	450

Very respectfully, your obedient servant,

A. F. FREIS,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

C.

HORSETAIL BAR.

REPORT OF MR. A. F. FREIS, ASSISTANT ENGINEER.

SAINT LOUIS, MO., *July* 22, 1882.

MAJOR: I have the honor to submit herewith a report of the operations of the work at Horsetail Bar, both on the Missouri and Illinois shores, for the fiscal year ending June 30, 1882.

First, in reference to the works on the west side, or Missouri shore, the present condition of which is represented on the tracing of the locality, Plate IV; also the total amount of construction placed upon the same, different letters being used to designate it, the notes of which are placed upon the tracing.

The primary line on the west side of the river was located July 16, from its upper end near the mouth of the River Des Peres, to the outer end of dike 1, points on the line being fixed by clumps of piles. The lower part of the line being located August 10, the construction of this line was pushed forward vigorously from the time of the location of the first section until about the latter part of September, when they were compelled to desist on account of the high stage of water; the piles driven in that time having extended for a distance of 6,075 feet, using 1,371 sticks of pile timber. There were also placed upon the primary line 5,311 linear feet of foundation mattress, starting from the river Des Peres and running down to secondary hurdle No. 3; starting again 170 feet above line No. 5, and extending to the end of the line, 1,000 linear feet of curtains; starting 50 feet above hurdle No. 1, and extending to hurdle line No. 3, 890 linear feet of plank gates; starting 250 feet above hurdle line No. 5, and extending to within 50 feet of No. 6, 3,650 feet of wattling, of which 450 feet is placed at the head of the line, the remaining 3,200 feet starting 50 feet above line No. 6; and running to the end of the line. The discrepancy between the figures given and the measured distance on the map is owing to lapage—that portion of the line between secondary lines Nos. 3 and 5 being in an unfinished condition on account of the submergence of the piles.

Work was resumed on the secondary hurdles on July 11, and continued until August 20, when they were completed with the exception of a passage-way for barges left between be primary line and the outer end of Nos. 2, 3, 4, 6, 7 and 8. Nos. 2 and 7, however, were afterwards extended to the primary line, secondary line No. 2 having been extended 174 feet, using 17 piles, 96 linear feet of curtains, and 92 feet of plank gates. No. 3 has been extended 266 feet, using thirty piles and 312 linear feet of curtains. No. 4 has been extended 348 feet, using forty-two piles and 408 linear feet of curtains. No. 5 has been extended 509 feet, using one hundred and forty-seven piles and 598 linear feet of curtains. No. 6 has been extended 581 feet, using one hundred and twenty-two piles, 620 linear feet of curtains, and 63 linear feet of plank gates. No. 7 has been extended 740 feet, using seventy-six piles, 840 linear feet of curtains, and 30 linear feet of plank gates. No. 8 has been extended 750 feet, using one hundred and seventy-seven piles, 512 linear feet of curtains, and 314 linear feet of wattling. No. 9 has been extended 72 feet, using four piles and 72 linear feet of gates. These works stood intact up to June 26, when the main row of piles of a section of the primary line, consisting of about 125 linear feet, gave way. This break started at hurdle line No. 8, and extended up stream for the distance mentioned; the points are represented on the map by the letters *h* and *k*.* This break was due to the erosion of the bottom, the depths of water given by soundings, ranging between 36 and 52 feet, the reading of the Saint Louis gauge being 28.9 feet. No attempt was made to repair it, as the works were all submerged.

There has been no work done on the Missouri side since its discontinuation in the latter part of September, 1881.

Appended is a tabular form of the hurdles constructed for the present fiscal year:

Location of hurdles constructed on Missouri side during fiscal year ending June 30, 1882.

Primary and secondary number.	Piles driven.	Foundation map placed.	Curtains placed.	Wattled hurdles.	Pine gates placed.	Total hurdles.	Completed.
		Lin. ft.	*Lin. ft.*	*Lin. ft.*	*Lin. ft.*	*Lin. ft.*	*Sq. ft.*
Primary line	1,371	5,311	1,000	3,650	890	5,390	91,310
Section line, No. 2	17	....	96	....	92	174	5,720
Section line, No. 3	30	....	312	....	....	266	8,246
Section line, No. 4	42	....	408	....	....	848	11,484
Section line, No. 5	147	....	598	....	....	509	17,312
Section line, No. 6	122	....	620	....	63	581	14,525
Section line, No. 7	76	....	840	....	30	740	17,029
Section line, No. 8	177	....	512	314	....	750	16,574
Section line, No. 9	4	....	....	....	72	72	1,368
Total primary hurdles	1,371	5,311	1,000	3,650	890	5,390	91,310
Total secondary hurdles	615	....	3,386	314	257	3,440	92,249
Total	1,986	5,311	4,386	3,964	1,147	8,830	183,559

ILLINOIS OR EAST SIDE.

Work at this locality was in progress at the beginning of the present fiscal year, a small force being engaged in reconstructing the primary line. This force was not increased until July 10, on account of the high-water that prevailed up to that date.

The work on the primary line had reached a point 200 feet below its intersection with secondary line No. 21, on the 1st of July, and was continued from that point downstream without interruption until about the last of September, when it was suspended, as the river had risen again, the line having been completed to its intersection with secondary hurdle No. 29, with a double row of piling driven from that point down to connect with secondary No. 30, the length of the line being 4,100 feet, expending thereby 1,052 piles, 2,585 linear feet of foundation mattress, 2,976 linear feet of curtains, and 425 linear feet of wattling.

The depths of water upon the line above secondary No. 24 were excessive, averaging between 24 and 26 feet, with the river at a 24-foot stage. They were, however, only equal to the average depth found in this vicinity since the works began, the current being, however, more favorable in velocity and direction than at any preceding time.

The plant having been increased the latter part of July by five pile-drivers and two barge-flats, a corresponding increase was made in the working force.

The work of repairing and extending secondary lines was commenced during the month of August, that of secondary 27 on the 18th, 29 on the 29th, while that of 30 was not commenced until September 6.

The equipment was increased about the 1st of September by three new drivers, which continued working at these points until September 27, when two of them were transferred to commence work at Twin Hollows. These were followed about the 1st of October by all excepting four of the drivers, the corresponding part of the force going with them. The force remaining continued work upon these lines until the last of October, when the pile-drivers and part of the force were transferred to line No. 18, to repair and strengthen it, the remainder of the force being transferred to the works at other localities.

Advantage was taken of the high stage of water during the month of October to construct line No. 30 across the bar, which was then submerged, but this water caused some damage to secondaries Nos. 27 and 29, and retarded their progress. The four pile-drivers, with the requisite equipment, continued the work of repairing and strengthening secondary hurdle No. 18 until the latter part of November, when the barges and all the drivers, with the exception of one, were placed in winter quarters. The repairing of this line continued until December 6, when the line had been completed to within 350 feet of the primary line. The plant was then sent to harbor, and the force disbanded on December 8. Work was not resumed again until March 20, when the plant, consisting of three drivers and a barge, were towed to the works, but the high winds prevailing during that season of the year caused such damage to the plant as to prevent active operations from being resumed until March 27, when the work consisted of repairing breaks in the primary line and secondary line No. 18.

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* Large scale map not forwarded.

In making an examination of the works it was found that the primary line had been damaged to a greater or less extent from secondary line No. 18 to line No. 24, the breaks occurring not being caused so much by the scouring out of the piles as by the drift and ice flowing against them during the winter and early part of the spring, which forced the piles over and broke them, thereby permitting such a volume of water to pass through as to eventually scour them out. The two principal breaks occurring in the primary line were between secondary hurdles 20 and 22, and midway between 22 and 24, that between 20 and 22 being 400 feet, starting 260 feet below line 20, and extending downstream; that between Nos. 22 and 24 being 450 feet, starting 150 feet below line No. 22, and extending downstream. The points are indicated on the tracings by the letters *m*, *n*, *o*, *p*. Operations were first resumed upon the gap between lines 20 and 22, the force having been able to work to greater advantage there than on the one below, as the piles at each end of this break were nearly all submerged. The three drivers continued work upon this gap from March 27 until April 1, when a double row of piles had been driven. Two of the drivers were then moved to the lower gap, the water having fallen, while the other driver commenced driving a third row of piles, starting from dike 3, the intention being to extend it to the lower end of the second gap. The object of this row was to facilitate the placing of a foundation mattress, that is to extend at least 30 feet in front of the main row. This line was run down stream for a distance of 1,300 feet.

The designation of the rows of piles is as follows: the middle being the main row the piles of which are driven 6 feet from center to center; the back one the bracing row, with the piles driven 12 feet from center to center, and 18 feet back of main row; the other, the outer, with the piles driven 24 feet from center to center, and 20 feet in front of main row.

The work of construction on the break between lines Nos. 22 and 24 continued until April 15, when a double row of piles had been driven. The driver was then moved to the section of primary line between secondary lines 19 and 20, continuing work thereon until the 22d, when they were placed upon secondary line 18 to repair the gap of 350 feet left open at the end of the first half of the fiscal year. The remaining driver continued work upon the outer row until April 22, when it was compelled to desist, as the water had risen so as to submerge all the lower end of the works. It was then moved to the primary line above secondary line 20 to replace all piles that had been broken between that point and line No. 18, continuing to work upon the same until May 6, and from that time until May 29 it was utilized placing booms on secondary line 18 and primary line.

The two drivers that had been moved to hurdle line No. 18 continued work upon this line until May 6, when all the piles necessary to close the gap had been driven. They were then transferred to other works, as they could not be used to further advantage here.

The number of linear feet of piles placed upon the primary line was 19,483, of which 14,944 feet were driven, consisting of 360 piles, and the remaining 4,539 feet, 160 piles, were used as booms and stringers. There has also been placed 1,170 linear feet of foundation mattress, starting 100 feet below dike 3, and extending 200 feet below line No. 21; 1,200 linear feet of plank gates starting from line 18 and extending to line 20, starting again 350 feet below line 20, and extending downstream for a distance of 100 feet. On the tracing *a*, *b*, *c*, *d* represent where the gates were placed, while *e*, *f* represent that of mattress.

The repairs on secondary line 18 were completed May 15, thus leaving the line in good condition out to the primary line.

This line gave way again on June 9 and 25 respectively, the first break occurring 300 feet and the other 800 feet from shore. These breaks were each about 100 feet long. They were due to the great quantity of drift collected against the line, and forced the piles over, represented by *o*, *p*, *r*, *s*.

The driver retained in harbor here was placed in requisition at once, and the work of repairing the gaps commenced and continued until the end of the fiscal year, when a double row of piles had been driven in the outer gap.

There has been placed in line No. 18, 8,249 linear feet of piling, 6,735 feet of which were driven, consisting of 168 piles. The remainder, 1,514 feet, 51 piles, were used as stringers and booms, 300 linear feet of foundation mat, 346 linear feet of plank gates. The two points are represented by *m n*.

The force, with the exception of a few men, were laid off on May 29, those retained being employed in the construction of gates. This force was not increased again during the fiscal year.

The following is the manner in which the plank gates have been placed: The gates having been constructed on the bank they were then placed upon a barge and towed to the works, where they were launched and floated to the place designated for them. Strong hinges having been previously placed upon one edge of the gate, these were made fast to the piles or stringers; the other end of it is then forced under water until the current catches it and places it against the piles.

In such places where the current comes directly against the gates they have been found effective, but when it cuts them obliquely some difficulty has been experienced in keeping them down against the piles.

The gates are made of yellow pine, the frames being constructed of 8 pieces of 2 by 6 inches, which are vertical when in position, with inch boards placed upon them diagonally, a space having been left between consecutive boards equal to the width of the board; they are 32 feet in length, and of a depth corresponding to the water of a 20-foot stage. See sketch showing elevation and section of gate in position, Plate V.

One noticeable feature of the work is, that when a line has been broken and a channel scoured, this channel persists in remaining for successive seasons after the line has been repaired.

The following table shows the location, extent, and character of the work done in constructing primary and secondary hurdles during the fiscal year:

Location of hurdles constructed on Illinois shore during fiscal year ending June 30, 1882.

Lines.	Piles for bracing.	Piles driven.	Foundation mat placed.	Curtains placed.	Wattled hurdles.	Pine gates placed.	Total hurdles completed in repairs and extension.	
	No.	*No.*	*Lin. ft.*	*Lin. ft.*	*Lin. ft.*	*Lin. ft.*	*Lin. ft.*	*Sq. ft.*
Primary line	160	1,412	3,755	2,976	425	1,200	4,300	95,070
Secondary line No 18	51	402	695	672	450	346	1,461	23,611
Secondary line No. 27	....	335	150	1,128	225	....	1,215	27,510
Secondary line No. 29	....	205	....	....	625	....	625	9,225
Secondary line No. 30	....	531	680	100	1,948	....	2,033	31,425
Total primary hurdle	160	1,412	3,755	2,976	425	1,200	4,300	95,070
Total secondary hurdle	51	1,473	1,525	1,900	3,278	346	5,334	91,770
Total	211	2,885	5,280	4,876	3,703	1,546	9,634	186,840

Tracing plate No. IV shows the condition of the bars formed within the constructed works as existing on June 30, in 1881 and 1882—that of 1881 being shown in a broken line, while 1882 is shown in dotted outline, the stage of water for presentation being taken at 12 feet, while some of the bars that existed at the end of the last fiscal year made their appearance at a higher stage of water than at present.

The general deposit formed inside of the works during the present fiscal year has been more evenly distributed than heretofore.

The following statement shows the material used in the works of construction at Horsetail Bar, for the fiscal year ending June 30, 1882:

MATERIAL USED IN CONSTRUCTION.

Brush	cords	1,755.54
Stone	cubic yards	1,436.54
Piles (2,636 piles)	feet	87,298
Rope	pounds	21,113
Spikes	do	4,960
Wire, No. 12	do	10,717
Iron	do	19,740
Nails	do	6,485
Bolts	number	4,126
Hinges	do	316
Lumber	feet	36,084

AUXILIARY WORK.

Upon the approach of the low stage of water, about the middle of September, the river fell faster than the bar was cut away; the current did not concentrate in one channel, but spread over the whole area between the primary hurdle lines.

Three distinct depressions were perceptible in the reef, in each of which there was a minimum depth of about 6 feet when the river reached the 8¼-foot stage. Channels passed through each of these depressions; one, flowing near to and parallel with the east primary line to a distance of 2,500 feet below dike No. 4, crossed the reef at that point, passed to the Missouri shore and reunited with the other channels at the point of the bluffs below Jefferson Barracks; a second channel, which could be run by descending boats, diverged from the former opposite secondary line No. 24, and crossed the reef in front of the old quarry on the barracks reservation; the third channel passed near the works on the west side of the river, and crossed the reef near the lower end of the primary line on that side. The best channel for navigation alternated between these ways, either of which had a greater depth of water than was in the river below, but the one on the west side of the river was decidedly the most desirable both for navigation and for the works.

The river, however, showed a tendency to concentrate in the eastern channel, threatening the destruction of the works on that side by the scour which would take place along the primary line. To prevent this and secure sufficient depth in the navigable channel, the opening of a channel through the reef was determined upon and the work was done—the work ending September 17—by means of water jets from the Worthington pumps on 4 pile drivers.

The drivers were firmly lashed together, two abreast, with the leads as nearly as possible in juxtaposition, and the 4 jets brought together. Three anchors were laid, by which the drivers were held in the line selected, crossing the narrowest part of the reef, and they were drawn backwards and forwards across the bar by means of the steam windlass connected with the crab machinery of one of the drivers. The greater part of the work was done while they were passing up stream. Work was begun on the 12th of September at 1 p. m., when, with 9.8 feet on the Walnut Street gauge, there was only 6 feet of water on the reef, and that only in a narrow channel. Soundings were taken at two o'clock on the following day, when 8¼ feet was the least depth found, the river having risen 0.3 of a foot in the mean time, and this depth was found in a channel of sufficient width for the largest tow on the river. The work was continued during the remainder of the week with marked success. The least sounding obtained on the 17th of September was 9½ feet, the river having risen 1.3 feet since work was begun. On October 10, with the water at 20¾-foot stage at Saint Louis, the least depth in this channel was 24 feet, showing a scour of about 7 feet since September 12.

Very respectfully, your obedient servant,

A. F. FREIS,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

D.

TWIN HOLLOWS, WEST BANK.

REPORT OF MR. W. S. MITCHELL, ASSISTANT ENGINEER.

TWIN HOLLOWS, WEST SIDE, *July* 20, 1882.

MAJOR: I have the honor to submit the following report of the operations, for the improvement of the Mississippi River near Twin Hollows, Missouri, for the fiscal year ending June 30, 1882:

That portion referring to the work done previous to January 1 is taken from the report of Mr. D. M. Currie, superintending engineer, for the half year immediately preceding that date.

An effort was made to begin the work at this point about September 1, 1881, but on account of a lack of facilities for subsisting men in large numbers in the vicinity, it was found impracticable to begin until the following month. During the latter part of September the preliminary work of definitely locating the lines of the proposed hurdles was done. Also there were erected a few portable buildings for the accommodation of laborers on the sand bar, or tow-head, lying to the east of the line of work.

On October 3 a large force of men with their quarters and a complete outfit of tools, &c., was transferred from Horsetail Bar, and the construction of the upper branch of the primary hurdle was begun at a point about 500 feet below the upper end, it having been found impossible to drive piles between that point and the shore. The depth of sand was found not sufficient to hold them, the strong current running close to the bank having scoured the bottom almost to the bare rock.

Soon after starting the river began rising and covered the sand bar near the angle in the primary hurdle. In order that piles might be driven over that portion of the work which was exposed at low stages, the pile drivers were dropped down stream to the angle and began driving over the bar. The water continued to rise, and soon reached a stage over 29 feet on the Saint Louis gauge, causing such deep and strong currents down the Missouri shore as to render it impracticable to resume work at the head of the primary hurdle during the remainder of the season. The construction of a dike to make this shore connection was begun, however, but only one mattress, 2¼ by 40 feet by 100 feet, was placed before the field-work was entirely suspended.

The completed portion of the primary hurdle was thus left detached from the shore, and, in consequence, the silting-up behind the wall was not as great as it would have been had the connection been made, yet the water during the rise being very heavily charged with sediment, the deposit within the areas protected by the hurdle was in excess of any expectation.

Work for the season was practically suspended November 26, almost the entire force being then transferred to Twin Hollows, east side, and the equipment was placed in winter harbor.

The small force of men left was engaged in placing the mattress above referred to and in bracing piles until the middle of December, when they, too, were transferred to Twin Hollows, east side.

During the time of operations, piles were driven for 5,575 linear feet of primary hurdle and 250 linear feet of secondary hurdle. There were placed 1,400 linear feet of foot mattress in double widths, and 3,000 linear feet in a single width. Wattling was done on 2,375 linear feet of the primary hurdle for a depth of 14 feet.

On the accompanying tracing* the work done during this season is shown in black, that in red being the result of the work done between March and July, 1882.

An examination of the work showed that the portion of the primary hurdle lying above the angle had been somewhat damaged during the winter, most of the piles in the up-stream part, unprotected either by foot mattress or wattling, having been scoured out. A few were standing, but were so bent down that it became necessary to pull and redrive them. The lower part, or 600 feet immediately above the angle, was unwattled also, but protected from scour by a foot mat of single width. Here the piles were in good condition, only a few requiring to be straightened or redriven.

Below the angle 1,425 linear feet of hurdle was found entirely complete and uninjured. The remaining 875 linear feet was also in good order, though there remained a single width mattress to be sunk outside of it.

Field-work was resumed March 13, four pile drivers being set at work on that day to repair the line above the angle and to extend it up stream as far as possible. Other pile drivers were soon added to the force until ten were engaged. These drivers were placed at work at the lower end of the primary hurdle to carry it down stream and to extend the secondary hurdles to the Missouri shore as soon as the primary line had reached points of junction with them. Constructing and placing mattresses was also begun and pushed forward as rapidly as the pile-driving would permit.

The methods used in the construction of these hurdles were practically those in vogue last fall. Piles were driven from 12 to 14 feet into the sand in two rows, 18 feet apart, with the piles space 6 and 12 feet apart in the front and back rows, respectively. A mattress of two courses of brush laid at right angles was then constructed on a strong grillage lashed to these piles for support. These mattresses were built in sections about 100 by 25 feet, and as they were completed they were unlashed from the piles and sunk to the bottom with stone. In secondary hurdles the single width mattress sufficed, but in the primary line another width lapping about 5 feet over the first was built on the channel side of the hurdle and sunk. In very swift currents this mat was supported on a third row of piles 20 feet outside of the first row, with piles spaced 24 feet apart. When the currents were not so strong flats were used instead of the piles. The gunwales of these flats having been raised, enabling their use in swift water, this third row of piles will in the future be required only where extraordinary difficulty is encountered.

After the first fortnight wire was used, to the exclusion of hide-rope, for binding these mattresses, Nos. 12 and 14 being found so flexible as to be easily handled, and much more strong and enduring.

The wattling was done in the ordinary way, the brush being laid in courses and pushed down with hurdling forks by men working from small flats.

It has been customary to strengthen the piles in the wattled row by bolting each pile at the top to a longitudinal stringer, and this practice was followed wherever the work had to withstand strong currents or drift, but at other points the stringer was omitted, it being thought that the wattling binding against the piles would furnish sufficient strength.

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* Tracing not forwarded.

On the completion of the wattling the line was braced by booms notched and drift-bolted into the head of the piles in the front row and heeled against the bottom of the pile in the second row. After examination of old work and experiment in placing these braces it was found that the large ring-bolt, used to guide the lower end of the pile to its proper place, seldom succeeded in keeping it in front of the guide pile, the current usually pushing it to one side. This impaired the usefulness of the brace, as it allowed the braced pile to work to and fro in the current. These rings were consequently discarded, and a clevis or stirrup made of 1 inch round iron, such as is shown in the accompanying tracing, Plate VII, was used in its stead. The usual size of the clevis was about 20 inches in length by 12 inches in width, and with a bolt about 17 inches long. The end of this bolt was heated and bent down when placed in the pile to prevent its working out. These clevises have given satisfaction wherever used; for, as they can be made to fit very closely to the guide piles by boring the hole for the bolt wherever necessary, they prevent the braces from slipping aside.

There was no especial difficulty experienced in building the hurdles, except that the secondary lines could not be brought nearer than to within about 250 feet of the shore on account of the deep water and strong current which enters through the opening at the head of the work. This current has so scoured the bottom along the Missouri shore that within 150 to 200 feet of the water edge the depths of sand are insufficient to hold the piles. Especially was the effect of this current and the drift felt in building the secondary hurdle No. 1. This line was driven and washed out in places three or four times, and finally carried away altogether, although driven in clumps of piles and placed without wattling. It was intended to protect the front of this line with brush curtains, woven on wire, and a number were built for that purpose on temporary ways erected on small flats. Only one of them was placed, however, the rapid accumulation of drift preventing the use of the others at that time. Drift has carried away about 500 linear feet altogether from the other lines of hurdles, besides interfering greatly with the constructing and sinking of mattresses and with the wattling.

At the head of the work a persistent effort was made to connect the upper end of the primary hurdle with the shore and thus relieve the work below of the pressure of water which it was called upon to bear and which has prevented such a deposit from forming near shore as would otherwise have been gained. This gap, by keeping a force of men engaged there, scattered the work over an area extending 1¼ miles up and down stream, making it difficult to get from one point of the work to another quickly, and preventing a concentration of the force on any one part of the work.

At first it was thought that the gap could be closed by anchoring curtains or mattresses of brush on the line and buoying their tops, hoping in this way to secure a deposit behind them in which a line of piles could be driven reaching nearly to the shore. Of the ten curtains (each 100 by 24 feet) constructed, only two remained in place after launching, and these are near shore at the extreme upper end of the line. The others were launched in deeper and stronger water and each in turn was at once forced below the line and in to the shore. They were not lost, however, but were afterwards towed by the steamer A. A. Humphreys outside of the primary hurdle and placed against it. They were made fast to the piles and served instead of wattling.

It being thus impossible to use curtains for the purpose, it was decided to build floating sections of hurdles without wattling, and to sink them in place like cribs, and afterwards to drop curtains in front of them to check the water. Such a structure was begun on May 13.

As will be seen from the tracing, showing plan, section, and elevation, Plate VIII, it consisted of upright piles and their braces, bolted at the top and joined at the bottom by a pile bolted to each, and forming with them a rigid triangle. To a number of these triangles, placed 6 feet apart, a floor was bolted. This floor was made of piles laid on two sills and drift-bolted to them, and served to hold the stone with which to sink the crib. A front and back stringer of piles bolted to the uprights and braces, and a wall of pine lumber fastened to the uprights completed the structure. It was 244 feet in length by 20 feet in width by 30 feet in height. It was hung between four barges, and on June 16 was floated out from shore and sunk in place. While sinking, two of the anchor lines with which it was secured gave way, and the crib was bent in the arc of a circle and was sunk in that position. It has not moved since, nor shown any sign of weakness. This crib, built entirely of piles, proved very heavy and difficult to handle, and the plan was considerably modified in the two which were next begun. One of these (250 feet long by 30 feet wide by 30 feet high) was intended to complete the closing of the gap at the head of the works, and the other (200 by 30 by 20 feet) to make the shore connection in secondary hurdle No. 1.

In these the width of the floor is increased to 30 feet, and it is made of pine lumber 16 feet by 8 by 6 inches, drift-bolted to three sills, spaced 14 feet apart. The sills were made of piles scarfed and bolted together, and running the entire length of the crib. The triangles were made with a vertical height equal to the depth of water in which they were to be sunk, and in order to distribute their weight more equally over the floors, were so made that the uprights and their braces made equal angles with the floor. To these triangles the floor is hung by stumps leading under the sill. The front wall was left off entirely, although the front and back stringers were retained. A stringer was also passed along the tops of the piles and secured to them with ring-bolts, so as to allow a little motion to the piles as the floor undulated in the waves. In the up-stream crib, in order to have the plane of the triangles when placed in the river coincident with the direction of the current, they were placed at an angle with the axis of the floor. This, as well as the general arrangement of the parts, may be seen in the accompanying tracing, showing a plan, section, and elevation of the crib, Plate IX. As the lower crib is intended to stand at right angles to the stream, the upright triangles were placed at right angles to the floor.

Thus far these cribs have fully justified expectations, being light enough to be supported on flats so that they may be readily handled. In building them, pile-drivers, with shears rigged at the leads, have been used to lift the triangles and piles into position and to raise the crib out of the water.

The early and long-continued high water was a source of great trouble throughout the entire season. From April 14 to July 1 the water surface was never more than 3 inches (and that for only four days) below the 20-foot level assumed as the height to which the work was to be brought; and it has been as high as 6 feet above it during the same time.

On account of this high water the force was reduced, June 1, in accordance with your verbal instructions, from about four hundred to one hundred men.

During the month of June no work was attempted save the construction of the cribs. This practically limited the working season to two and a half months.

During this time the primary hurdle was extended 7,000 feet, of which 2,650 feet were entirely completed. A single width mattress was sunk on 1,500 linear feet of the old work, and of this 650 feet was also wattled. Double width mat was sunk over 2,350 linear feet of the new work, which remains unwattled. On 1,500 linear feet the piles alone were driven.

It was originally intended to place the secondary hurdles every 400 feet, but it was afterwards decided to increase this distance to 2,000 feet, and that the new No. 1 should be built on the line originally intended for No. 6. Only four of these hurdles were begun. Of these, 1,800 linear feet (Nos. 3 and 4) were entirely completed and the piles and mattress were placed for 1,600 linear feet more (Nos. 1 and 2.) Altogether there were wattled 4,100 linear feet of hurdle, averaging 10 feet in depth. In addition there were made and sunk 1,040 linear feet of brush curtains, averaging 25 feet in width, and there were woven on wire 360 linear feet of curtains 22 feet in width.

One crib was constructed and sunk and two others were partially completed.

In closing, I desire to express my thanks to Messrs. J. L. Duffy, Sidney B. Cady, and J. W. Irwin, assistant engineers, for the valuable assistance given by them in the prosecution of the work.

Very respectfully, your obedient servant,

WM. S. MITCHELL,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

E.

CARROLL'S ISLAND.

REPORT OF MR. C. V. MERSEREAU, ASSISTANT ENGINEER.

TWIN HOLLOWS, EAST SIDE, *July* 19, 1882.

SIR: I have the honor to submit to you the following report of operations at Carroll's Island for the year ending June 30, 1882.

PROTECTION OF CARROLL'S ISLAND.

The protection of the lower part of the west bank of Carroll's Island was formerly considered a necessity in connection with the improvement at Horsetail Bar, but when the flood of last spring had subsided, erosion of the bank had ceased. A sand-bar having extended from the head of the island to some distance below the point where it had been most active, the necessity seemed to exist no longer, but later active erosion began on the bank below, and, working up stream as the water fell, reached a distance of about ½ of a mile above the foot of the island, about the middle of September.

The activity of this erosion was such that the necessity of protecting the bank soon became evident, and that work was begun October 3, at the upper point named, by the method designed for that purpose as shown in drawings* furnished with your verbal instructions, consisting of a mattress 120 feet wide to protect that portion of the bank below the plane of ordinary low-water; a revetment of stone between that and the 20-foot stage, using loose brush mats to cover the surface of any portion of that zone which happened to be under water at the time that any revetment should be constructed; and plantations of willows from that stage to the top of the bank, grading the bank to a regular slope before planting the willows.

A line of guide piles spaced 15 feet between centers was driven as nearly as practicable 15 feet inshore from the curve of standard low-water, following the general alignment of the bank; and guided by this line the mattress was constructed upon floating ways.

The length under process of construction at any one time was about 25 feet, which was the available width of the barge upon which the ways were floated, and also about the length of poles used.

The poles were about 6 inches in diameter and were made continuous by splicing them together, for which purpose two consecutive poles were lapped about 4 feet, and were well fastened with wire and spikes. The brush was from 2½ to 4 inches in diameter and 30 to 35 feet in length, wattled upon the poles by passing a rod of it alternately above and below them.

The rods used in wattling to make a course in the mattress were lapped about 6 feet, but each was left detached. The butts of the rods at the edges of the mattress were turned outward and about every fifth rod on top or every tenth one of the whole was nailed to the poles at each edge of the mattress.

One mattress was built during the season, which was found to be 1,695 feet long when completed. That the length is greater than was originally intended may be due to circumstances which prevented the floating of it until 1,000 feet could be finished.

On account of the drift-wood under the head, sections on the upper end had to be placed when only about 700 feet had been constructed, and in order to complete the section to the original length, a part only was sunk, leaving enough afloat to keep the connection unbroken. Afterwards the sinking followed the construction, about 200 linear feet being left afloat, until the whole was launched and sunk at the lower point of the island.

This experience indicates that mattresses can be continued and successfully placed in sections of any desired length under ordinary circumstances of weather, drift-wood, velocities, and direction of currents during an entire working season.

The placing of the first section so that its inner edge would coincide with the curve of standard low water was an interesting subject of study; this required that the mattress should sink vertically, neither dropping down stream nor being hauled up stream during the process. That was accomplished by attaching lines to its head long enough to keep the up-stream end of the mattress practically in the same vertical plane while passing from the surface to the bottom, passing them under the barge, and making them fast to suitable moorings on shore as a preliminary step toward sinking; but, before beginning that work, strains were brought upon these lines by means of a Spanish windlass, heaving them so taut that no slack was perceptible. The tensile strain on all the lines is measured by the resistance that the sinking mattress offers to he free flow of the water. This could not be exactly determined, the data required for such calculations being unknown and scarcely attainable.

The experiment proves, however, that mattresses can be successfully placed with an edge coinciding with a given line and in long sections, or continuous, at nearly if not quite all localities on this section of the river requiring protection. The depth was not great, and the velocity of the current at the stages prevailing while the mattress was under process of construction was less than would be found at most of the points requiring protection on account of the volume of water which flowed through the passage east of the island with a greater velocity than that of the main channel, checking the velocity on the west side of the island farther up stream than the head of the work.

The experiment was purposely tried in the comparatively slack water, taking all the precautions that would be necessary in swifter currents to train the overseer and others in the details of the work preparatory to making the more severe test of sinking the mattress upon the bank below, where both depths and velocity are great, while the direction of the current sets across the mattress, forming conditions no more favorable than would be found at a large majority of caving banks. About half of the mattress was placed on a bar not less than 18 feet above low water, where the bottom was from 7 to 10 feet below that plane when the work was begun.

As a broad, high bar formed outside of the island during the decline after the November flood, work above the plane of standard low water, including the revetment, grading, and planting of willows, was unnecessary at that time, and that part of the protection was left to await future developments. The work was completed on December 10, 1881, and the force transferred to Twin Hollows, east side.

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*See Plate XIV.

During the season 1,695 linear feet of mattress 120 feet wide were constructed and placed, in the construction of which 1,467.9 cords of brush, 600 cubic yards of stone, and miscellaneous material to the value of $898.35 were expended.

The value of bank protection either as a means of improving or preserving a channel often depends upon the rate at which it can be completed, and for that, among other reasons, an effort was made to determine the maximum rate at which such mattresses could be constructed consistent with economy in cost. Unfavorable circumstances conspired to prevent satisfactory conclusions being reached. During a great part of the season heavy rains fell almost daily, the river was high and rising, large masses of drift accumulated under the mattress, and laborers were continually changing, few remaining long enough to become expert in construction, most of them moving farther south as fast as they came into possession of sufficient funds. Under such conditions a fair test could not be made, and the maximum rate obtained cannot be considered as an overestimate of that which can be accomplished under favorable circumstances. When working a full force 100 linear feet per day were constructed and launched, which amount may be increased as the workmen have become expert.

The sketch forwarded herewith, Plate X, shows the location of the work.

Very respectfully, your obedient servant,

C. V. MERSEREAU,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

F.

TWIN HOLLOWS, EAST BANK.

REPORT OF MR. C. V. MERSEREAU, ASSISTANT ENGINEER.

TWIN HOLLOWS, EAST SIDE,
July 13, 1882.

SIR: I have the honor to submit to you the following report of operations at Twin Hollows, east side, for the year ending June 30, 1882:

PROTECTION OF TWIN HOLLOWS, EAST SIDE.

The work of protecting the bank at Twin Hollows, east side, was begun on October 26, 1881, by a force of men transferred from the works at Carroll's Island.

The method employed was that designed for the purpose.* It consists of three parts: a low water mattress 120 feet wide, the shore edge of which is placed on the line of standard low water; a revetment extending from the edge of the mattress to 16 feet above standard low water; grading of the bank to a uniform slope of 2 to 1 and planting with willows.

The low water mattress, 120 feet wide, was constructed by wattling brush upon from 22 to 30 weaving poles. The number of poles depended on the size of the brush furnished, the short light brush requiring more poles than the larger and thicker brush. The poles were made continuous by being lapped about 4 feet, spiked and wired. Their ends at the head of the mattress were secured by being treenailed to a heavy cross-piece by 1¼ inch pins.

In the construction the poles were evenly distributed over the ways, and the upper ends secured to the cross piece. The down-stream ends were cut off even with the ends of the ways. The brush was then wattled on the poles by passing a rod of it alternately above and below them. The brush was wattled on the down-stream end of the poles, then slipped down and made tight by the use of large wooden mauls. The brush used to make a course was lapped about 6 feet, but was left detached. The butts of the brush were turned outwards, and every tenth one nailed to the poles at the edges of the mattress. The brush was wattled on the poles to within about 4 feet of their ends. The barge carrying the ways was then dropped down stream sufficiently to allow the portion of the mattress already constructed to be drawn to the lower ends of the ways. New poles were then spliced on to those in the portion just launched and the wattling continued. The amount of mattress under construction at any one time was from 20 to 30 feet, the latter being the available width of the mattress barge.

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* See Plate XIV.

The size of the poles ranged from 2 to 5 inches at their small ends and from 5 to 9 inches at their larger ends. The brush was from 20 to 40 feet long and from 1¼ inches to 4 inches in diameter.

Work on the mattress was begun on October 26, and pushed forward till December 10, when, all of the brush having been used from the Illinois shore, the mattress was launched from the ways and placed. The entire length of this mattress was 1,245 feet. It was woven continuous, and no trouble was found in making it conform to the general contour of the bank, although there were several short, sharp bends.

The storm of November 19 and 20 drove the mooring barge hard aground and swung 150 feet of the upper end of the mattress in over the guide piles. When placed the inner edge was in contact with the bank at the water surface instead of at the line of standard low water. This portion was made to form part of the revetment mat. No trouble was experienced in sinking this portion of the mattress.

The mattress work was resumed on December 17, the brush being cut for the purpose on Carroll's Island, and 248 linear feet constructed before the work was discontinued on account of unfavorable weather. In sinking this small section a piece 75 by 35 feet broke off from and was doubled under the outer edge, by the strong current. By loading the mattress in the middle the broken portion was brought to the surface and afterwards sunk in its proper position.

Work was discontinued on January 8, 1882, on account of unfavorable weather.

During the season 690 linear feet of loose brush mat for revetment, averaging 40 feet wide, was constructed and placed.

The work of last season was inspected on March 7 by Mr. J. O. Holman, who had been appointed resident engineer, and found in good condition. During the following week a kitchen crew and part of the outfit arrived, and the quarters were put in good condition. The low water mattress was begun on March 21, and has been continued up to the present writing, with but few interruptions. It was commenced at station 14 + 80 and made continuous to station 53. On April 4, the first 400 feet sunk easily and in good condition. The inclined portion was held in position by two small flats. The storm of the following week sunk one of the flats and broke a piece about 30 feet by 50 feet from the outer edge of the mattress. Considerable difficulty was experienced sinking the next 800 feet (station 20–station 28). The current was strong and the water from 36 to 40 feet deep on the outer edge of the mattress. Extra bracing was put on after each sink, still the outer edge was broken more or less between these points. None of the breaks extended, however, over 50 feet in from the outer edge, and they would probably average about 35 feet.

On April 16 the sinking from station 28 to station 33 was successful.

The sinking from station 34 to station 39 was attempted April 27. Two mooring barges were used, the upper one at station 34 and the lower one at station 39. Lines were made fast to the mattress above and below the barges so as to give as long a slope as possible between the sunken and floating portions. The rock barge was placed just below the upper mooring barge. The mattress was sinking in good condition when the lines by which the barge was held parted, and the barges swung against the mattress. The pressure with the inshore current pushed the mattress in against the piling and doubled the outer edge under to station 39, where it was held by the lower mooring barge. At station 39 the mattress tore about two-thirds across. This portion was afterwards examined by a diver, who reported it about 70 to 85 feet wide. From station 39 to station 45 the mattress was sunk in good condition. The inclined portion below station 45 was held in position by barrels. On May 12 an attempt was made to sink the mattress from station 45 to station 51, at which point the inclined portion was to be held in position by three rows of barrels. The current was very strong and struck the mattress obliquely between station 45 and station 51. The mattress parted at station 48, and it was wrecked as far as the mattress barge at station 53. It also carried away six of the ways from the barge. The wrecked portion was loaded and sunk. It probably covered a width of about 80 feet.

On May 15 the mattress barge was taken back to station 46 and a new mattress begun with a grillage of poles beneath.

The section extending from station 46 to station 59 + 25 was sunk on June 12. The method of placing was as follows: A line of barges was dropped along the outer edge of the mattress. They were held in position by a head-line leading up to the shore and two anchors to each barge placed quartering out and up the stream. Lines from the barges were made fast to the mattress, part of them passing under the barges. Sufficient strain was then put on the anchor-lines to hold the mattress out from the piling and to prevent it sagging down stream. Two barges partly loaded with stone were then hauled over the mattress near station 53 and the stone from one of them evenly distributed over the mattress as it was hauled up. In this partial loading care was taken not to load the mattress more than the lines from the barges would hold The partial loading sank the mattress from 2 to 7 feet below the surface of the water, and extended from station 46 to station 53. The second partially loaded barge of stone was placed across the mattress just below the mooring barge, and a barge fully loaded placed across at station 53. The head of the mattress being held from the mooring barge was then heavily loaded and lowered into position. The line leading under the mooring barge and up shore from the head of the mattress prevented it from sagging down stream. The lines from the barges were paid out gradually as a heavy strain came on them. The upper portion of the mattress went down without a break in it. While the head was being lowered the barge at station 53 was being dropped down over the mattress, loading it as it went. Through mismanagement of the barge a break occurred at station 55, and the outer edge was more or less folded for about 100 feet. Between station 56 and the end of the mattress (station 59 + 25) it went down in good condition. A new section of mattress was immediately begun, and its construction is still being pushed forward. The grillage of poles was dropped after the first 200 feet. On June 30, 964 linear feet had been constructed.

The revetment had been extended from station 11 + 50 to station 22, and from station 48 to station 49 + 50. The loose brush mattress under the revetment was discontinued below station 11 + 50 and stone alone used.

Eight hundred linear feet of shore mattress, averaging 75 feet wide, were put in. That placed from station 14 + 50 to station 17 was to bring the mattress work into low-water. Between station 33 and station 37 and stations 48 — 49 + 50 it was put in to stop caving of the bank.

The bank between stations 0 and 21 was graded by the use of the hydraulic excavator. The ground was full of brush and stumps, making it difficult to grade. The average rate of grading was about 100 linear feet per day. High-water has prevented the continuation of the grading.

Five small hurdles were constructed for the breaking up of eddies. They are located at stations 14 + 50, 17, 34, 35, and 43.

The current appears to have followed the mattress barge as it was moved down stream, and formed an eddy 200 or 300 feet beyond it.

The bank has caved very rapidly in some places as the mattress approached it. However, but little caving has taken place after the mattress has been placed.

The sketch forwarded herewith, Plate XI, shows the condition of the work on June 30. The red line shows the location of the shore line on March 27. That in black is the present shore line. The soundings are those taken in May, excepting those along the mattress, which were taken as the mattress was constructed.

During the year there have been constructed 7,564 linear feet of low water mattress, 5,900 feet of which have been placed, 964 feet are ready for placing, and 700 feet wrecked, but on the bottom, in which were expended 4,621.89 cords of brush, 2,112.36 cubic yards of stone, 552 piles, and miscellaneous material to the amount of $1,766.51 (miscellaneous material); 1,950 linear feet of shore mattress, averaging 50 feet wide, in which were expended 1,176.81 cords of brush, 184.11 cubic yards of stone, and miscellaneous material to the amount of $97.05 (miscellaneous material); 1,500 linear feet of riprap, in which were expended 709.64 cubic yards of stone.

Very respectfully, your obedient servant,

C. V. MERSEREAU,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

G.

BEARD'S ISLAND.

REPORT OF MR. J. W. RECORD, ASSISTANT ENGINEER.

BEARD'S ISLAND, ILL., *July* 17, 1882.

SIR: I have the honor to submit herewith the following report of operations at Beard's Island for the year ending June 30, 1882:

I first arrived on the ground on March 17. The island at that time was being cut away at its west bank from a point about 2,000 feet below the head of the island to the extreme lower end. For 2,000 feet below the head of the island there was very little waste. At the first opportunity I made a survey of the west bank of the island, and established a line, with stations every 100 feet, to refer the work to.

This survey showed that the island had been cut away at places more than 800 feet since the survey was made in 1880, and an average width of nearly 600 feet the entire length of the island. The channel of the river was inside the position of the old shore line for nearly the whole length of the island. The current was not very strong along the bank above station 20, except for a distance of about 200 feet at the head of the island, where it was very strong, and its direction inclined nearly 90° to the shor line.

Below station 20 the current was very strong, and its direction also inclined to the shore line.

The works at this place have been the construction of a bank protection and a hurdle about 1,000 feet long to close a chute at the head of the island. The bank protection consisted of a continuous mattress 120 feet wide,* that extends up to the standard low water line, and a stone revetment that extends 16 feet above this line.

There were delays in getting the pile-driver started which delayed operations several days, and the construction of the mattress was not begun until the last day of March. Progress was quite slow at first, the average amount constructed per day for the first week being only 54 feet; but the rate increased each week as the foreman and laborers learned to apply their labor to a greater advantage, until it reached 108¼ feet per day for the week ending May 13. The largest amount constructed in any one day was 130 feet. The mattress construction was continued until 1,100 feet were completed, when 900 feet of it were sunk. Sinking the mattress has been the most difficult part of the work at this place. The first 900 feet were sunk without special difficulty, the current being feeble and the water shallow. The barge of stone was drawn up to the mooring barge and stone thrown on the outside corner of the mattress. It was then allowed to sink, by means of dropping lines fastened to the mooring barge, just enough to let the stone barge pass over it. Stone was then thrown over the mattress and the end allowed to sink to the bottom. As the barge drifted down broadside across the mattress enough stone was thrown on to sink it. This method of sinking did very well in a gentle current and where the water was not very deep, but where the water was deep and the current strong it was found that it would be necessary to buoy it up at the outside by means of barges anchored in the stream, and not leave it free to the action of the current.

During the month of April 1,600 feet of mattress were constructed and some 1,300 feet sunk. After the first 900 feet were sunk shorter sections of 300 or 400 feet would be sunk at a time, at intervals of three or four days, until 2,000 feet had been sunk.

From station 16 to station 30 the shore line bends through an angle of some 25°. The current was strong and its direction inclined to the bank. For these reasons it was thought best not to sink short sections at a time and leave it to the action of the current in the bends, but to let it lie on the surface of the water until enough had been constructed so as to be able to sink through the worst place all at once. On May 19 the mattress was completed to station 33, of which 1,300 feet were still on the surface of the water. It was intended to sink 1,000 feet of this May 20, but all the stone on hand was expended in sinking 600 feet. This left the mattress in a very bad condition. That part of the mattress between the bottom and the surface of the water came opposite a sharp curve in the mattress. The current was strong and its direction inclined to the bank. The sinking was done Saturday afternoon, and no more stone could be procured before Monday. The mattress held together until the evening of the next day, when it broke. It was made secure as soon as possible by fastening two lines at the outer edge, but before this could be done it got badly skewed; the outer edge moving down stream, while the shore side was held by the yokes. On the next day an effort was made to sink the broken section, but it was so badly skewed that it broke several times while sinking. It all sunk, but in a very bad condition.

A mooring barge was then set at station 32 + 50. Only 360 feet, however, had been constructed when the mooring lines broke and let the end of the mooring barge swing down stream, which crowded the ways barge against the guide piles so hard that the mattress could not be continued. It was launched from the ways barge and sunk. An enormous amount of drift had collected under the mooring and filled the entire space between the barge and the river bed for one-half the length of the barge, forming a kind of "rack-heap," which remains there to-day. During the month of May 2,000 feet of mattress were constructed. I then had orders to construct a short section of mattress to repair the broken place in the mattress first constructed. It was known that it broke at the shore edge at station 26. A careful examination was made at the outer edge, but the water being 40 feet deep it was impossible to determine much in regard to its condition. I had the mooring barge set at station 25 so as to be reasonably certain the mattress would cover the gap. Three hundred feet were constructed at this place. It was finished June 14, and sunk June 16. The velocity of the current had diminished a great deal here since the first mattress was sunk, and it was not necessary to use a mooring barge alongside while sinking.

A mattress was then started at station 35 + 50. It progressed very slowly; the high-water and the great amount of drift rendering its construction extremely difficult, so that on June 30 only 540 feet had been constructed.

None of the stone revetment was laid until May 18, and then only for a short distance at the head of the island. It was afterwards continued as fast as the stone could be obtained, and on June 30 was completed as far as station 16 + 50, with the exception of two small sections.

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* See Plate XIV.

April 26 I received orders to construct a hurdle to close the chute at the head of the island. A pile-driver was immediately set at work driving the piles. On May 31 all the piles were driven and a foot-mat 450 long constructed and sunk. The high-water then stopped operations for several days, and washed out the piles for a distance of 150 feet. As soon as the water fell below the tops of the piles the wattling was commenced. The sediment drifted in and deposited nearly as fast as the wattling was completed, and the work was pushed as fast as possible in order to obtain the benefit of the high-water. It was completed June 29, and at that time a deposit had formed nearly to the top of the piles.

On the accompanying map* figures in red indicate soundings taken March 31; figures in black those taken June 30; the former soundings raised to the stage of water of the latter.

Before closing I will express my thanks to Mr. J. E. Savage, assistant engineer, for his intelligent assistance and the interest he has shown in the work.

Very respectfully, your obedient servant,

J. W. RECORD,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

H.

"JIM SMITH'S."

REPORT OF MR. JOHN O. HOLMAN, ASSISTANT ENGINEER.

JIM SMITH'S, ILL., *July* 11, 1882.

SIR: I have the honor to submit the following report of the preparatory work of May, and the construction work of June, comprising all that has been performed at Jim Smith's during the fiscal year ending June 30, 1882.

Four portable buildings, to be used as office and quarters, were in process of erection from May 23 to May 27. Two pile-drivers, on the 29th, 30th, and 31st, drove a number of piles for mooring barges to be used during the construction of secondary hurdles at the upper end of work.

On June 1 the initial point was changed, being moved up stream 3,800 feet.

The construction work has all been on the primary hurdle line, beginning at the upper end, and during the month of June there was made 850 feet of foot-mattress, of which 800 feet was sunk into place; 500 feet of wattling on primary hurdle line, varying from 2 feet to 22 feet in height, and 250 feet of hurdle mattress 10 feet in width; 426 piles were driven.

The tracing of the progress map, forwarded with this report,† shows, in addition to the primary hurdle line and the completed work, the projected cross hurdle lines.

The line FE was the primary hurdle line as originally given, but this was extended to F′ on June 1. The line F′FE is 17,125 feet long. The secondary hurdle lines, numbered on the tracing from 1 to 9, vary in length from 800 to 1,950, and have a total length of 11,350 feet. The shore lines are from survey made June 26 to June 28, inclusive. The dotted shore lines from survey of 1881 show the bank receded 750 feet at secondary hurdle No. 8, and 300 feet at secondary hurdle No. 3. The soundings were taken from a yawl June 29 and 30.

The cross lines on FF′′ are 100-foot stations. On the tracing the heavy line to station 15, the line to station 9, and the line to 8 + 50 represent, respectively, the drift row, the hurdle row, and the bracing row, and the length to which they were extended from F′ by the driving done during June.

A stringer has been placed on the entire length of the drift row, secured to the piling by large screw bolts. The depth of water and strong current made it necessary to use these in order to keep the piles from working loose. The hurdle line has been secured with stringers immediately after driving, and during the high water the braces have been placed and fastened to the hurdle row after the foot-mattress is sunk, and before the wattling is done. This will not retard the wattling materially, for the time lost in passing brush around the piles in the hurdle row and under the stringers has been regained by more rapid work due to steadiness of the piles in the hurdle row.

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*Large scale map not forwarded. Location of work shown on Plate XII.

† Large scale map not forwarded. Location of work shown on Plate VI.

The hurdle line is wattled to station 5, dropping in height from a 27-foot stage at the bank to a 22-foot stage at station 5. The wattled curtain was placed from station 5 to 7 + 50. It was built in 85-foot lengths, and was used where the water was too deep to allow of wattling with the forks now in use. These wattled curtains were constructed in the following manner: Poles of about 35 feet in length were placed across the piles, one just ahead of each hurdling pile and resting on the stringers of the hurdle and drift rows, being secured by rope lashings to the hurdle stringers. That portion of the poles between the hurdle and drift rows was then woven with brush to a distance of 10 feet from the drift piles, the men working from flats while weaving. Fastenings were made with wire to hold the edge of the curtains securely to the poles. A sketch has been made, and is forwarded with this report, showing the plan, elevation, and section of the wattled curtain, Plate XIII. In the plan a portion of curtain is shown just before launching from the stringers of the drift row. The weaving-poles are lashed to the stringers of the hurdle row and an anchor-line is fastened from the wattled end of the upper weaving-poles to a hurdle pile about 100 feet up stream. Large stones are wired to the upstream end of the curtain, which after being swung against the hurdle row by the current will sink to the foot-mattress. The dotted lines in the section *a c* give the position after swinging against the hurdle row. In sinking to the foot-mattress the lines are slackened so that the poles will rest against the piles, as shown in the elevation. A spike in the end of the weaving-poles holds the curtain in place until the wattling, which, as shown by the elevation and section, embraces the pole and pile, thus effectually securing the wattled curtain in place.

From 2, on the 1st of June, the number of pile-drivers was increased to 7 on the 14th. They were in continuous use driving, with the exception of No. 1, which was used in placing the braces on the brace row of piles. A brace was placed at each brace pile, secured to it by a clevis, the upper end of the brace being notched into and bolted to the hurdle pile. The braces are not quite in line with the current, but make an angle of about 45° with the brace line.

Two sets of quarters on barges, and one set on shore, have been in constant use. An additional set was erected on shore at the upper end of the works, but was not in service during June.

I remain, very respectfully, your obedient servant,

JOHN O. HOLMAN,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

I.

ENGINEER DEPOT.

REPORT OF MR. C. L. STEVENSON, CLERK.

UNITED STATES ENGINEER DEPOT,
Saint Louis, Mo., July 7, 1882.

SIR: Agreeably to paragraph 88 of the regulations for 1882, I have the honor respectfully to submit a condensed report of the operations at the Engineer Depot for the fiscal year ending June 30, 1882.

The equipment was increased during the year by the construction of eleven pile-drivers, numbered from 11 to 21, inclusive; one hydraulic excavator, numbered 1; two mattress barges, numbered 2 and 3, respectively; thirty-seven portable shanties for quarters; eighty flat-boats; twenty-nine coal-barges, of which twenty-seven were on hand at the beginning of the year, and two purchased since were altered for barge-flats.

The pile-drivers were built of same general design as those described in previous reports, except that the water supply for pumps on those numbered from 17 to 21, inclusive, was increased by enlarging the surface of the strainer from 19 to 50 square inches.

No. 11 was completed and put into service about the middle, and Nos. 12 and 13 the last, of July; Nos. 14, 15, and 16 completed in August; 18, the last of November; and 19 and 21 finished in December.

The hull of excavator No. 1 is of the same model and dimensions as those for pile-drivers, with the addition of a guard 2 feet wide on each side. The cabin is 20 feet broad, 48 feet long, 11 feet high. It is equipped with a Worthington compound duplex steam-pump, having two 12-inch and two 18-inch cylinders connected with two cast-iron shoes by a 7-inch copper pipe. The discharge—about 700 gallons per minute—passes first through a 6-inch pipe, then through a Y-shaped pipe, the two arms being 4½ inches each in diameter, and, connected with a hose of same size, is delivered through two nozzles, each 2 inches in diameter.

The excavator—commenced about 1st of August—was completed October 20.

The mattress barges are 150 feet long over all, 8 feet rake, 28 feet wide, and 5 feet gunwale depth. A bulkhead runs fore and aft, resting on an 8 by 10 inch keelson, with fore and aft strokes on each side of the bulkheads, having stanchions under the middle streaks, and the beams and decks of substantial material.

Way pieces of oak, 3 by 6 inches, arranged for building a mattress 120 feet wide, extend over one side 15 feet. These barges were commenced August 27, and completed—No. 2 on the 1st and No. 3 on the 20th of October.

The flats are:

24, 6 feet broad, 20 feet long, 12 inches deep.

26, 9 feet broad, 30 feet long, 16 inches deep.

30, 9½ feet broad, 35 feet long, 22 inches deep.

Sixteen of the twenty-six were subsequently altered by adding to the top of the gunwales 6 inches, making them 22 inches deep.

The small flats are used for calking barges, bracing hurdles, and other light work, and the larger ones for general use in connection with the construction of hurdles.

The portable shanties for quarters number as follows, viz: Twelve mess-rooms and kitchens, each 20 feet broad by 60 feet long; fourteen sleeping-rooms, each 20 feet broad by 45 feet long; four foremen's quarters, each 20 feet broad by 15 feet long; three foremen's quarters, each 20 feet broad by 30 feet long; four offices and quarters, each 16 feet broad by 32 feet long; the latter for assistant engineers. Each set of quarters is furnished with a proper complement of such bunks, tables, benches, wash-stands, closets, mess furniture, and cooking utensils as are necessary for the service for which such quarters are respectively intended.

The portable shanties (designated by letters) are similar to those built last year, which are fully described in the last annual report.

The coal-barges were purchased to be altered for carrying material and for other service connected with the work on the improvement of the river. They are about 134 feet long, 24 feet broad, and 7½ feet hold, and are numbered from 28 to 56, inclusive. They were strengthened by placing new stiffeners and side clamps the whole length, most of them with two new fore and aft bulkheads, new deck frames, decks, capstans, pumps, timber-heads, &c.

Slight repairs were made to flat barges Nos. 31, 33, 36, 46, and 48.

Barges Nos. 12, 13, 14, 17, 18, 19, and 20 were overhauled and thoroughly repaired, most of them receiving new deck frames, decks, timber-heads, and other substantial repairs.

A new hull was built for pile-driver No. 2, of same dimensions as those previously made; a new crab placed on pile-driver No. 5; new brace to leaders of pile-driver No. 3; ways were extended and other repairs made to mattress barges Nos. 2 and 3.

Repairs were made to steamers Humphreys, Anita, and steam launch Hornet. To the former guards and nosing on both sides from bow to engine-room, plank sheaves, kevels, fenders, stern bulkheads, chocks, deck to the after end of coal-room, and four boiler-deck stanchions were renewed; capstan, railing on both sides, and other general repairs were made. There were added also a bracket-boom, foundation, and other necessary arrangements for an electric light on the boat. The main and boiler decks of the Anita were repaired, some of it relaid and renewed, the nosing, plank sheaves, chocks, stock-knees, bits, caps, kevel, and some short hoods renewed, and other general repairs made. The steam launch Hornet was drawn out of water, overhauled, thoroughly repaired, and painted; new cylinder timbers, two strainers to supply pipes, and other additions made.

Preparations for an engineer depot on the ground in front of the old arsenal south of Arsenal street began on the 21st of January by leveling the irregularities in the ground. A portion of the old arsenal wall was removed so as to construct a roadway to a landing. Two rows of piles driven for a hurdle line, which was partly completed, a distance of about 135 feet from the wall into the river, were used to construct a roadway for shipping purposes, the way being 18 feet broad, extending to a platform at the end of it about 20 by 26 feet.

The buildings which have been erected here are: one office, 16 by 32 feet, with 8 feet ceiling, which is divided into two rooms of equal size and used as offices for the material and subsistence departments, respectively; one warehouse, 125 by 25 feet, 13 feet ceiling, used for storing material; one warehouse of same dimensions as the last, used for subsistence stores. Under this house is a cellar full size of the building, ceiling 6½ feet in the clear, with solid stone walls, plank floor, and properly drained by pipes leading to the river. One house, 20 by 40 feet, 8 feet ceiling, used as carpenter shop; one house, 20 by 50 feet, 8 feet ceiling, for blacksmith shop, arranged for six forges; one house, 16 by 70 feet, 8 feet ceiling, for oakum-room.

The blacksmith shop and oakum house were reconstructed mainly of material removed from the buildings used for same purposes at Marine avenue. One house, 16 by 20 feet, 8 feet ceiling, for oil-room and paint shop. All of these buildings are substantially made, of good material, shingle roofs, and proper complement of glazed windows. The rooms for offices are weathered and ceiled.

All implements, tools, appliances, repairs, alterations, and other work of like description needed from time to time by the several engineer and other parties connected with the works immediately below Saint Louis, which requisitions in the aggregate amount to a considerable number, have been filled here.

The material for building new hulls to pile-drivers Nos. 3 and 5 has been framed and prepared to be put together, but further work thereon has necessarily ceased, recently, on account of the extraordinary high water in the river.

With much respect, your obedient servant,

C. L. STEVENSON,
Clerk.

Maj. O. H. ERNST,
Corps of Engineers.

K.—*Record of gauge at Grafton, Ill., for the fiscal year ending June* 30, 1882.

[Height of water above a plane 200 feet below the Saint Louis City directrix.]

Day.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	206.00	200.80	195.86	202.22	212.00	208.48	203.50	198.10	201.50	204.96	211.00	211.10
2	06.50	00.55	95.30	02.80	12.35	07.50	02.85	98.28	01.92	05.00	10.90	11.28
3	06.86	00.25	95.32	03.85	12.50	07.00	02.40	98.10	01.76	05.10	10.70	11.65
4	06.70	199.95	95.40	05.30	12.65	06.55	02.15	98.00	01.84	05.35	10.45	11.80
5	06.50	99.50	95.45	06.40	12.80	06.00	01.80	98.50	02.00	05.40	10.60	11.80
6	06.00	99.15	95.50	06.70	12.87	05.60	01.50	98.45	02.32	05 35	09.40	11.84
7	05.30	98.60	95.60	06.75	12.89	05.20	01.15	98.45	02.55	05.35	08.30	11.88
8	04.15	98.22	95.82	06.74	12.90	04.85	00.85	98.52	02.78	05.14	08.35	11.88
9	03.30	97.80	96.00	07.20	12.80	04.60	00.90	98.60	03.10	05.40	10.15	11.68
10	02.54	97.50	96.30	07.30	12.70	04.45	00.82	98.70	04.00	05.35	10.20	11.35
11	01.80	97.20	96.65	07.00	12.45	04.00	00.70	98.52	04.95	05.64	10.90	11.00
12	01.84	97.00	97.00	06.80	12.50	03.90	00.55	98.80	05.44	05.90	11.22	10.45
13	01.60	96.70	97.16	06.75	12.50	03.88	00.45	98.38	05.20	06.20	11.22	10.25
14	02.85	96.40	97.38	06.84	12.50	05.00	00.45	98.44	04.80	06.60	11.22	10.25
15	03.50	96.25	97.56	06.95	12.55	05.00	00.45	98.46	04.52	06.95	11.10	10.40
16	04.50	96.15	97.70	07.10	12.50	04.50	199.80	98.30	04.20	07.20	10.92	10.65
17	05.20	96.00	97.92	07.60	12.36	04.40	99.40	98.74	04.15	07.35	10.80	11.10
18	05.80	95.90	98.10	08.10	12.80	04.00	99.00	98.90	04.05	07.68	10.42	11.55
19	06.30	95.85	98.22	08.75	13.50	03.70	98.70	99.10	04.05	07.60	10.50	11.46
20	06.75	95.82	98.45	09.20	13.94	03.42	98.54	204.34	04.25	07.00	10.18	11.05
21	07.20	95.90	98.55	09.70	13.78	03.22	98.15	08.50	04.46	06.90	09.80	10.70
22	07.65	95.90	98.70	10.20	13.25	03.50	97.85	09.50	04.90	07.15	08.35	10.50
23	07.75	95.92	99.00	10.60	12.60	03.95	97.70	09.02	05.04	08.10	08.70	10.16
24	07.54	95.90	99.10	10.85	11.90	04.20	97.80	06.00	05.04	08.94	07.90	09.92
25	07.05	95.85	99.55	10.95	11.20	04.20	98.10	04.52	05.00	09.40	07.75	09.50
26	06.00	95.74	99.85	11.20	10.60	04.00	98.10	02.74	04.90	10.00	06.85	09.18
27	04.50	95.74	200.16	11.40	10.02	03.95	98.10	01.60	04.94	10.45	06.90	09.48
28	02.85	95.62	00.40	11.55	09.48	03.95	98.10	01.10	04.80	10.60	08.00	09.90
29	01.90	95.62	00.75	11.70	08.95	03.80	97.90	....	04.85	10.95	09.12	10.53
30	01.36	95.50	01.50	11.85	08.48	03.80	97.75	....	04.90	11.05	09.75	11.86
31	01.00	95.40	....	11.90	....	03 80	98.05	....	04.95	....	10.40	......

L.—*Record of gauge at Alton, Ill., for the fiscal year ending June* 30, 1882.

[Height of water above a plane 200 feet below the Saint Louis City directrix.]

Day.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	199.85	193.87	188.82	194.86	203.42	200.15	195.62	190.60	195.85	197.05	203.43	205.22
2	200.65	93.60	88.25	95.45	03.68	199.75	95.10	90.62	95.62	97.20	03.25	05.52
3	01.23	93.30	88.28	96.60	03.80	98.82	94.65	90.49	94.87	97.25	02.82	05.65
4	01.25	92.97	88.32	98.02	03.92	98.40	94.50	90.42	94.65	97.24	02.85	05.45
5	01.05	92.60	88.35	98.57	04.00	97.97	94.21	90.48	94.87	97.20	02.00	05.15
6	00.54	92.22	88.38	98.80	04.08	97.52	94.00	90.55	95.00	97.15	01.75	04.95
7	199.65	91.87	88.46	98.95	04.10	97.34	93.88	90.72	95.15	97.04	01.55	04.93
8	98.60	91.40	88.58	99.00	04.08	97.04	93.25	90.78	95.80	97.05	01.45	04.85
9	97.58	91.10	88.80	99.45	04.02	96.55	93.26	90.96	95.70	97.85	01.75	04.50
10	96.60	90.75	89.15	99.55	03.87	96.32	93.05	90.90	96.75	98.24	02.35	04.00
11	95.72	90.45	89.52	99.85	03.75	96.08	92.92	90.78	97.85	98.35	02.90	03.45
12	95.10	90.22	89.70	99.42	03.78	96.05	92.78	90.60	98.15	98.70	03.05	02.75
13	95.05	89.97	89.98	99.37	03.85	95.85	92.62	90.67	97.95	99.10	03.08	02.25
14	96.15	89.72	90.18	99.33	04.05	96.85	92.68	90.78	97.55	99.68	03.05	02.25
15	96.80	89.48	90.35	99.30	04.70	97.55	92.79	90.82	97.20	200.45	03.02	02.38
16	97.75	89.32	90.48	99.28	04.83	97.45	92.62	90.72	96.87	01.00	02.92	02.55
17	98.45	89.22	90.68	99.50	04 75	96.88	91.78	90.60	96.70	00.75	02.72	03.43
18	98.92	89.12	90.80	200.02	05.35	96.82	91.32	90.72	96.62	00.30	02.50	04.55
19	99.30	89.02	90.95	00.83	07.40	95.85	91.22	91.62	96.73	01.00	02.35	04.50
20	99.76	89.00	91.07	01.50	07.35	95.50	90.98	98.30	96.90	199.82	02.33	04.00
21	200.00	88.97	91.22	02.28	06.80	95.25	90.58	204.50	97.25	99.45	02.25	03.65
22	00.22	89.00	91.38	02.68	06.05	95.47	90.18	04.85	97.55	99.55	01.65	04.32
23	00.28	89.02	91.55	02.98	05.30	96.08	90.06	03.76	97.45	200.55	00.85	04.50
24	00.15	88.96	91.75	03.35	04.55	96.52	89.98	01.90	97.42	01.83	00.25	04.45
25	199.78	88.85	92.00	03.55	03.62	96.68	90.16	199.90	97.30	02.25	199.67	04.03
26	98.88	88.80	92.27	03.72	02.66	96.65	90.38	98.05	97.22	02.58	99.95	03.60
27	97.70	88.70	92.58	03.78	01.92	96.52	90.70	96.55	97.10	02.88	200.00	03.55
28	96.05	88.62	92.83	03.65	01.28	96.35	90.55	95.45	97.05	03.08	01.85	04.28
29	94.98	88.50	93.08	03.55	00.70	96.05	90.80	....	97.00	03.30	03.52	05.00
30	94.47	88.42	93.62	03.47	00.15	95.95	90.12	....	96.98	03.42	04.15	05.94
31	94.05	88.35	....	03.42	....	95.92	90.42	....	97.00	....	04.70	......

M.—*Record of gauge at Gray's Point, Missouri, for the fiscal year ending June* 30, 1882.

[Height of water above a plane 200 feet below the Saint Louis City directrix.]

Day.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	109.16	102.96	....	100.61	110.41	109.01	104.91	105.01	114.16	106.66	111.66	114.76
2	09.06	02.31	....	100.61	10.41	08.16	04.61	05.11	13.96	06.66	11.76	15.01
3	09.66	02.01	....	02.11	10.41	07.51	04.06	05.11	12.51	06.66	11.66	15.31
4	10.46	02.26	....	03.41	10.46	06.96	03.51	04.76	11.61	06.51	11.41	15.41
5	10.76	01.56	....	05.51	10.61	06.51	02.96	04.76	10.66	06.16	10.91	15.31
6	10.66	01.26	....	06.16	10.66	05.96	02.61	04.61	10.06	05.76	10.41	15.01
7	10.36	00.61	....	06.31	10.91	05.66	02.26	04.41	09.66	05.41	10.01	14.66
8	09.66	00.46	....	06.46	11.01	05.06	01.86	04.11	09.41	05.41	11.11	14.41
9	09.26	00.06	....	07.36	11.01	04.66	01.61	03.96	09.16	05.16	10.66	14.16
10	08.91	00.56	....	07.61	10.91	04.16	01.61	03.76	09.41	05.51	11.16	13.91
11	06.91	99.21	....	07.26	10.66	03.76	01.86	03.51	09.41	06.41	11.31	13.86
12	06.01	99.01	....	07.16	11.01	03.51	01.76	03.06	10.31	06.76	12.11	12.86
13	05.16	98.66	....	07.56	10.91	03.16	02.06	02.76	10.76	07.01	12.51	12.01
14	04.76	98.36	96.96	07.66	11.01	03.61	02.66	02.61	10.91	07.41	12.66	11.16
15	05.41	98.16	97.26	07.61	11.31	03.61	03.06	02.51	10.61	08.41	12.61	10.76
16	05.36	97.66	97.51	07.41	12.11	04.51	03.66	02.66	10.11	09.41	12.51	10.66
17	06.56	97.46	97.66	07.21	12.66	05.41	04.26	03.61	09.51	10.36	12.31	10.66
18	07.31	97.26	97.96	07.26	13.16	05.26	04.41	03.76	09.01	10.31	12.01	11.11
19	07.66	97.26	98.61	07.46	14.06	04.66	04.16	03.96	08.61	09.91	11.76	12.66
20	07.91	97.36	98.76	08.16	15.91	04.26	04.06	05.51	08.51	09.41	11.61	13.26
21	08.16	97.16	98.76	08.91	16.46	03.66	04.16	12.66	08.66	09.01	12.01	13.41
22	08.36	97.26	98.76	09.96	16.31	03.41	04.26	17.91	08.66	08.66	11.91	13.66
23	08.36	97.06	99.01	10.46	15.66	03.16	04.41	19.16	08.51	08.51	11.61	14.01
24	08.41	97.16	99.16	10.66	15.21	03.61	04.41	19.51	08.31	09.11	10.91	14.41
25	08.31	97.06	99.31	11.01	14.06	04.41	04.51	19.01	08.11	09.16	10.16	14.61
26	08.06	97.06	99.86	11.16	13.46	05.26	04.61	18.11	07.66	11.01	09.51	14.51
27	07.56	96.86	99.66	11.41	12.51	05.76	04.61	16.41	07.61	11.16	09.76	14.66
28	05.56	96.66	99.91	11.41	11.41	06.01	04.76	15.31	07.26	11.31	10.41	14.01
29	05.31	....	100.06	11.16	10.51	05.86	04.91	....	07.11	11.51	11.41	14.36
30	04.26	....	100.26	10.91	09.76	05.61	05.01	....	06.91	11.61	13.36	14.66
31	03.41	....	....	10.41	....	05.26	05.01	....	06.66	....	14.01	......

N.—*Depth of water upon the bars between Saint*

Date.	Stage above standard low-water by Saint Louis gauge.*	Name of steamer furnishing report.	Arsenal Island (head).	Arsenal Island (foot).	Horsetail (middle).	Horsetail (lower), Carroll's Island.	Twin Hollows.	Widow Beard's.	Jim Smith's.	Bridgewater or Foster Island.	Herculaneum (swash in) Lucas.	Platin Rock.
1881.			*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Aug. 3	11.20	City of Alton			9½	13½		10½	7(?)	10½		
4	10.80	Grand Tower	15		12			15	16½	12		
5	10.45	Ste. Genevieve			12			12		12		
5	10.45	Humphreys										
6	10.00	......do			11	10		12	12	15		16½
6	10.00	Fearless				10½		10½	13½	9½	15	
7	9.75	City of Vicksburg	13½		10½			10½	8			15
8	9.20	Humphreys			10½	13						
11	8.10	W. P. Halliday	8½	13½	8				9			13½
11	8.10	Anita			10½	10½		9	9	9		15
13	7.85	Humphreys			8	9		8	8		7	13½
12	7.85	Ste. Genevieve			8	7½			9	8		
14	6.90	City of Greenville	10½		8½			8	9			12
16	6.60	Anita			8	10½		9	7	7		15
17	6.45	......do										
17	6.45	Humphreys			8	6½		7	7½		6	10½
18	6.40	F. A. Blanks			6½	9		9	8		6½	
19	6.30	Humphreys			8	8		7	8½		7	9
19	6.30	Ste. Genevieve			6½			6½	6½	6½		
20	6.15	John Gilmore			6½	9		7	8½	6½		
20	6.15	City of Vicksburg	10½		7	7					7	
21	6.00	Humphreys			7	7			9		8	9
21	6.00	Belle of Shreveport	9		7½	10½		8	9		9	
22	5.95	Anita										
23	5.90	City of Providence			7			8				
23	5.90	John Gilmore			7	10½		7½			6½	
24	5.90	Humphreys			7	7		9	9		7	9
24	5.90	Commonwealth			8½	9		6	6		8	
25	5.85	Humphreys										
25	5.85	City of Alton	8½		8			6½	9	6½		
25	5.85	Gold Dust			6½				8½		7	10½
26	5.60	Anita										
28	5.30	City of Greenville	9		6½	9	8	8	8		7	
29	5.15	Humphreys			7	7		7	8			
30	5.00	......do									7½	
31	4.90	Anita										
Sept. 1	4.75	Humphreys	9		6½	6		6½	7		6½	7
1	4.75	Anita										
2	4.75	John B. Maude	12		6				6½	6		
3	4.60	Anita										
6	4.80	Humphreys	9½		6	7		8	7		5½	8
8	4.90	......do	10½		7½	10½		8	8		8	8½
8	4.90	Belle of Shreveport	15	15	5½	9			9		10½	
8	4.90	Gold Dust			8							
8	4.90	Annie P. Silver	10½		7	7		7	10½		6½	
13	6.10	Humphreys	10½		8	10½		8½	10½		8	9
13	6.10	Commonwealth	9		7	9		7	9		7	
13	6.10	Montana	9		6½	9			8			
16	6.75	Humphreys	10½		8½	12		9	10½		9	10½
16	6.75	Anita										
16	6.75	John B. Maude			7			8		9		
16	6.75	C. P. Chouteau	10½		8½			9			6	
18	7.35	Will. Kyle							10½		9	
19	7.45	Jay Gould			8	9½						
20	7.50	Humphreys	12		9	12		10½	10½		10½	10½
24	8.15	......do	12		9	12		10½	12		12	10½
30	9.50	Anita										
30	9.50	Humphreys	13½		12	12		12	12		9½	10½
1882.												
Feb. 2	6.15	City of Alton	15		7	9	7	9	7½		7½	9
3	6.10	Commonwealth			7	8	8	8	9		7	8
4	5.85	City of Vicksburg			6½							
4	5.85	Baton Rouge			7	9	8	10½	10½	8		9
7	5.95	City of Providence			7	7½	9		9	7½		12
9	6.25	A. P. Silver			7½	9½	8½	12	12	8½		
12	6.25	City of Greenville			7¾	9	8½	10½	12	7		
13	6.30	Ste. Genevieve			8½	10½		8½	12			
13	6.30	Halliday			7		9	9½	10½		8½	
17	6.35	Commonwealth			6½		8		10½		7	9

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* Standard low-water, 4 feet above low water of 1863.

Louis and Cairo, as reported by pilots.

Cornish Island.	Selma (Kennett's Castle).	Forest Home.	Perry's T. H.	Rushtower Bend.	Fort Chartres.	Turkey Island.	Saint Genevieve Island.	Saint Genevieve Bend.	Kaskaskia Island. Fairy Island.	Saline Creek.	Saint Mary (Rozier's).	Mary's River (Block's).	Liberty Island.	Jones' Point.	Wilkinson's.
Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet*	*Feet.*	*Feet.*	*Feet.*
			12		16½			12	11			12	9	9½	
			12		16½			13				12	9		
									9½				9		
			12		18	16½	15	13½	12				10		
			8½						12				8		
			10½		16½			13½	8		13½	9½	8	9	
	10½				16½	9			9		10½	8½	10½	6½	
			12		13½	12		10½	9			9	6	8	
	9		8		12	9	12	9	7			10½	6		
	8						7		9				9½		
	9½		8½		12			9	8			9	12	6½	
		8	18½												
					10½	9		9	8			9	6½		
	8½		9		10½			7	9			10½	9		
	9	9	8			10½		7	10½			9	6½		
	9		6		9	8½		7	8			8	9		
								7	10½			8	6		
		7½	9	12	12	9		7½	16½			8½	6½		8½
	8		8					7			9	7			
			6½		13½	9		6	7		9	8	6		
	10½	8			12		12	7	9		9		10½		
												9	6		
											7	8	6		
	9														
				8½				6			7	8½	5½		
			8		9	9		6½	7		7	7	9		
13½	9½	9	9		12	12		7			10½	8	6½		
		8	7½									6½	6		
												9	6		
	8		9	10½	12	6		7½			6	9½	5½		
			8		9½	7		5½	7		7	7	9		
	6½	6½	8		9			5½				8			
												10½		5½	
		6						6½						5½	
												10½		6	
	6½	7	8			7		6		6½		8	9		
	8	6½	8½			7		6	6½	6½		8		5	
		6½						5½				8	12		
														5½	
	7½		9			7½		6		7		8		6	
	8	8	8		10½	8		7		8		8	10½		
10½	9	7	9		10½	9		7		7		9		7	
	10½									7		8		6	
	9	9	9		10½	8		7½	9	8½		8½	10½		
												12	8		
	9							6½						6½	
			8½					9						6½	
	8							9		8½			9		
			9						9				8		
	9	10½	9		12	10½		9	10½	9½		9½	12		
	10½		10½		12	10½		9	12	10½		9½	12		
												15	12		
	10½		10½		12	10½		10½	12	10½		10½	12		
	7		8		9	9		10½	8			8	7	10½	
	7		6½							8		8			
													6½		
7½	7½		8	10½	12					8		9	7	12	
7½	7½		9							8		9	8	9	
8	8		8		8½							10½		12	
7½	7½		9½							8		9	7	10½	
	7			8									9		
10½			9							8				10½	
	7		8							8		9	8		

N.—Depth of water upon the bars between Saint

Date.	Stage above standard low-water by Saint Louis gauge.*	Name of steamer furnishing report.	Hat Island.	Crawford's.	Tea Table.	Moccasin Springs (Bee).	Hamburg.	Swift Shore.	Kinney Point.	Devil's Island (middle).	Floral Creek.
1881.	*Feet.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet*	*Feet.*	*Feet.*	*Feet.*
Aug. 3	11.20	City of Alton	18	12					9	12	10½
4	10.80	Grand Tower	16½	12					15		9
5	10.45	Ste. Genevieve								8	
5	10.45	Humphreys									
6	10.00	do									
6	10.00	Fearless									7
7	9.75	City of Vicksburg		9				8½			9
8	9.20	Humphreys									
11	8.10	W. P. Halliday	9		9	13½		9	8½		8½
11	8.10	Anita	13½	8							7
12	7.85	Humphreys									
12	7.85	Ste. Genevieve		9							7½
14	6.90	City of Greenville		9							8
16	6.60	Anita									
17	6.45	do	13½	8					9		8
17	6.45	Humphreys									
18	6.40	F. A. Blanks		6						8	8
19	6.30	Humphreys									
19	6.30	Ste. Genevieve								6	8
20	6.15	John Gilmore		7		12				7½	8
20	6.15	City of Vicksburg	10½	7½						7	7
21	6.00	Humphreys	10½	6½							
21	6.00	Belle of Shreveport	12	7		7½				8	7½
22	5.95	Anita	12	7					9		7
23	5.90	City of Providence									
23	5.90	John Gilmore		6½						8	8
24	5.90	Humphreys									
24	5.90	Commonwealth		7½						7½	8
25	5.85	Humphreys									
25	5.85	City of Alton		7		10½				8	8
25	5.85	Gold Dust	10½	8						5½	6
26	5.60	Anita	12	8					9	8	
28	5.30	City of Greenville		6						7	6½
29	5.15	Humphreys									
30	5.00	do									
31	4.90	Anita							9		8
Sept. 1	4.75	Humphreys									
1	4.75	Anita	18	6							
2	4.75	John B. Maude		7			9			6½	6
3	4.60	Anita	18	7					9		8
6	4.80	Humphreys									
8	4.90	do	8	6½						7½	7
8	4.90	Belle of Shreveport		6						8	8
8	4.90	Gold Dust									
8	4.90	Annie P. Silver		7						6	7
13	6.10	Humphreys									
13	6.10	Commonwealth		9						7½	8
13	6.10	Montana		8							
16	6.75	Humphreys									
16	6.75	Anita	18	9						9	9
16	6.75	John B. Maude		9						7½	
16	6.75	C. P. Chouteau								7½	
18	7.35	Will. Kyle		10½						9	
19	7.45	Jay Gould									
20	7.50	Humphreys									
24	8.15	do									
30	9.50	Anita	19½	12						15	13½
30	9.50	Humphreys									
1882.											
Feb. 2	6.15	City of Alton	12	8						9	
3	6.10	Commonwealth									
4	5.85	City of Vicksburg									
4	5.85	Baton Rouge		8			9			8½	
7	5.95	City of Providence		9			12			8½	8½
9	6.25	A. P. Silver		10½			9½			8½	
12	6.25	City of Greenville		8			9	10½		6½	
13	6.30	Ste. Genevieve		8½						6½	6½
13	6.30	Halliday		8½			9			8	
17	6.35	Commonwealth		8						9	

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* Standard low-water, 4 feet above low water of 1863.

Louis and Cairo, as reported by pilots—Continued.

Cape Girardeau (Wahoo).	Burnham's or Santa Fé Island. Beaver Dam Rock.	Jacket Pattern.	Atherton's.	Goose Island.	Hacker's Bend.	Buffalo Island.	Saladin T. H.	Thompson's.	Scudder T. H.	Greenleaf's.	Abel's T. H.	Pond Lily.	Eliza Point.	Greenfield's.	Cairo Point.
Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
15		10½											6½	8½	
15													6½	8	
13½													6½	7	
10½												6	6		
15		10½							16½		12	6½		8	
13½		9		10½	9				16½		10½	7			
13½															
16½		7			9½					8½			6½	6	
12		9	9	9	9								6½	7½	
10½															
9		8		10½									8	8	
		7										7	6	6½	
9		9		10½	9			13½	12		10½		8		
10½		7		9	9		10½		18½		7½		7	7½	
10½				8½			10½	12	10½		10½		7	6½	
10½															
	8	9											8	6	
	9			7½	9				15		8½		5½	7	
9	7	8		8	9			13½						6	
9½	7														
10½															
9	7			7	8			12	12				7	6	
10½															
10½															
9															
9	8			6			9	13½	9		6		6		5
															5½
9	6½				9		8½	10½	8½		8½		5½	9	
9	7	9		9							9		6½		6½
		9		9			10½						6		
12															
	7½												7		6
													7		7
	9													7½	
									13½				8		5
15															
10½															
10½															
8½															
10															
12															

R 2.

IMPROVEMENT OF THE HARBOR AND MISSISSIPPI RIVER AT ALTON, ILLINOIS.

The Mississippi River at Alton is shown on Plate XVI. The Alton landing lies just below a sharp turn in the Illinois bluff. The channel of the river for several miles above the city follows these bluffs in almost a straight line. Reaching Alton, it crosses to the head of Ellis Island, leaving comparatively dead water in front of the landing, the result of which is a shoal. This shoal at low water shuts off all access by vessels to the down-stream portion of the landing and renders access to the up-stream portion inconvenient.

The plan proposed by me, and adopted by a Board convened to consider the subject by my predecessor in 1880, was to construct a dike, AB, beginning at a point on the Missouri shore about 1½ miles above the dam across Alton Slough and running diagonally down stream a distance of about 4,800 feet. If necessary, the dike was afterwards to be continued upon a line nearly parallel to the Illinois shore, which made a small angle with the first line of direction. The dike AB was designed to collect all the waste water of the river, and, throwing it against the channel as it came down the Illinois shore, to divert the channel and cause it to attack the shoal in front of Alton. It was to be built to a height of 14 feet above low water.

The execution of this plan was begun this year, but the method of construction adopted was different from that proposed in 1880. I believed at that time that it was worth while to try the permeable system in the Upper Mississippi, but I afterwards became convinced that the chances of its failure were much greater than those of success. Alton being situated above the mouth of the Missouri, it would not be judicious to apply it here. I accordingly prepared a design for a dike which should be substantial enough to resist of its own weight the destructive forces of the river. In its general outline it resembles the dams constructed upon the Illinois and Upper Mississippi for some years back, the principal new feature being the method of constructing the mattresses. Its details are shown on Plates XVII, XVIII, and XIX, and are fully described in the report of Mr. C. D. Lamb, assistant engineer, hereto appended, marked A.

The work was begun in September, but was suspended in October on account of high-water. This being the low water season, the foremen and plant were kept together, in the expectation that the rise was but temporary. This proved not to be the case, and in November the force was disbanded, only eight mattresses having been placed in position. The work was resumed about the 1st of April, and made satisfactory progress until the 17th of June, when the appropriation became exhausted and it was again suspended. The first or bottom tier of mattresses has been placed for a distance of 2,040 feet from the Missouri shore; the second tier for a distance of 780 feet; the third tier for a distance of 1,421 feet; and one mattress has been placed in the fourth tier.

The dike is about one-third completed. It has caused a strong current in the desired direction, which is now exerting a scouring influence upon the shoal in front of Alton. It will no doubt remove a part of the shoal, but to fully complete the work it should be extended and raised.

The work was under the direction of Mr. C. D. Lamb, assistant engineer, whose report is hereto appended and is intended to form part of this report. It contains the details of construction and of the different items of cost. He was aided by Mr. Gerald Bagnall, assistant engineeer.

The expenditures were $33,324.70, for which sum 23,700 cubic yards of dike were constructed. The cost was therefore $1.41 per cubic yard, all contingencies being included. A more favorable working season would have largely diminished the cost.

Money statement.

July 1, 1881, amount available	$33,324 70
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	33,324 70
Amount (estimated) required for completion of existing project	*51,675 30
Amount that can be profitably expended in fiscal year ending June 30, 1884	16,700 00

A.

REPORT OF MR. C. D. LAMB, ASSISTANT ENGINEER.

ALTON, ILL., *July* 1, 1882.

MAJOR: I have the honor to submit the following report of operations for improving the harbor and Mississippi River at Alton, Ill., during the fiscal year ending June 30, 1882.

In accordance with your instructions received on September 16, 1881, I proceeded immediately to Alton and made arrangements for carrying on the work.

The river and harbor at that place seemed to have undergone but few changes since the survey of 1879, the most important being the increased size of the body of water passing down on the Missouri side of Ellis Island, this part of the river being much larger relatively than in 1879.

This change was due partly to the gradual lowering of the crest of the stone dike behind the head of Ellis Island, and partly to changes in the channel above, which caused a large body of water to run down next the Missouri shore. There had also been a gradual filling up of the lower part of the harbor on the Illinois side, but on account of the prevailing high stages of river, steamboats have experienced no difficulty during the past year in landing at any part of the wharf above the ferry dock, which lies at the foot of the improved levee.

Operations were begun as soon as the plant had been towed to the location of the work, and conducted in accordance with your letter of instructions dated September 16, 1881, of which the following is the substance:

"The dike A B is to be built to a height of 14 feet above low-water, made of brush mattresses loaded with stone, sunk tier upon tier, as shown in section on Plate XVII, each layer to be kept horizontal, filling the deepest parts of the line first. The lower tier sunk in juxtaposition with guide-piles, driven 40 feet apart, upon the line marking the down-stream edge of the dike, and each succeeding tier to be set back 8 feet from the down-stream edge of the tier below. The mattresses to be 42 feet wide, 2 feet 6 inches thick, and of a length convenient for handling, constructed upon a grillage composed of eight continuous poles, fixed 6 feet apart, running lengthwise of the mattress, and held in position by cross-poles at intervals of 25 feet. Upon this grillage a layer of brush 15 inches thick to be placed athwart the poles, then a second layer of the same thickness, to be placed at right angles to the first; upon this layer a grillage of poles to be placed athwart the mattress, as shown in the plan and elevation of Plate XVII. The whole to be sewed through and fastened at each intersection of the grillage poles with annealed wire."

The line of the dike was located and the driving of guide-piles began September 27. The extension of the line was continued, with frequent interruptions for the purpose of driving clumps of mooring piles and repairing breaches made by drift, until November 5, when the guide-line had been extended to a length of 3,600 feet. The driving of piles was then discontinued.

The construction of mattresses was begun as soon as a supply of brush could be procured, and continued until six mattresses had been placed in the deep water near the shore end of the dike, five on the bottom and one on the second tier. One mattress was lost, after being partly sunk, by the breaking of the lines used to hold it in position.

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* Estimate of last year diminished by $35,000, the amount allotted by Congress from appropriation of August 2, 1882, for improving Mississippi River from Cairo to the Illinois River.

Work was suspended October 23 on account of the high stage of water which covered the bottom land near the dike, where the mattresses were being constructed. The force was not, however, disbanded, and two mattresses were left upon the ways partly finished, as it seemed probable that the river would soon subside. But as the water continued to rise during November, and reports from the upper river gave no hopes of an immediate fall, the two mattresses on the ways were completed and placed, one on the second, the other on the shore end of the third tier. Work was suspended for the season November 22, when the tow-boat was turned over to its owners, the equipment having been put into winter quarters behind Ellis Island.

In accordance with your letter of instructions dated November 12, 1881, the plant and material on hand were turned over to Assistant Engineer D. M. Currie, the barges being towed to Saint Louis by the steamer A. A. Humphreys and laid up behind the foot of Carroll's Island.

In accordance with your letter of instructions dated March 23, 1882, operations were resumed April 3.

But little change had taken place in the harbor since the work was suspended in the fall. The bar at the outer end of the dike had moved down stream about 300 feet, while the erosion of the Missouri shore above and below the dike had become very marked, but the shore end of the dike rested upon a hard clay bank, filled with roots, which showed no signs of cutting.

The mattresses placed during the fall season were found in position, but most of the guide piles had been carried away by ice and drift during the winter.

The driving of guide piles was begun April 10, and continued until the line had been repaired to a length of 3,000 feet. The pile-driver was then towed to Saint Louis May 4.

The construction of mattresses was begun as soon as a force of laborers could be organized and the ways repaired, the material on hand at the close of the fall season having been returned by Assistant Engineer D. M. Currie.

Forty-seven mattresses, each 80 feet long, were constructed and placed during the last half year, of which number twenty-one were placed on the bottom tier, extending it to a length of 2,040 feet; eight on the second tier, completing it to a distance of 780 feet from its shore end; seventeen on the third tier, which was extended to a length of 1,420 feet; and one on the shore end of the fourth tier, which also served to protect the bank at the head of the dike, being assisted by a revetment of stone, which extended about 100 feet above the dike.

The appropriation being nearly exhausted, work was suspended June 17. The force was disbanded and paid, the equipment towed to Saint Louis, and the tow-boat turned over to its owners.

The total number of cubic yards of dike constructed during the year was 23,700, of which the total cost was $33,324.70, or $1.41 per yard. The cost of the work done during the first half year was $2.90 per cubic yard, the season being a most unusual one on account of the heavy and frequent rains and the resulting high stage of river. The cost of the work done during the last half year was but $1.10 per yard.

The total number of linear feet of mattress constructed during the year was 4,400. Of this number 4,320 linear feet were successfully placed.

The total cost of building and placing a mattress 100 feet long, 42 feet wide, and 2½ feet thick was as follows:

112 cords of brush, at $1.94		$217 28
136 pounds of wire, at 4.96 cents		6 76
44 pounds ¾ Sisal rope, at 7.7 cents		3 11
14.3 pounds Sisal hide rope, at 7.6 cents		1 09
Cost of material		228 24
Labor of actual construction		116 39
Equipment		11 81
Miscellaneous, labor, and contingencies		110 21
Cost of mattress ready for placing		466 65
Labor of placing	$49 37	
152.7 cubic yards of stone, at $1.05	161 07	
Towage	77 39	
		287 83
Total cost of mattress in position		754 48

Of the foregoing cost, 30 per cent. was expended for the material and 16 per cent. for the labor required for the actual construction of a mattress 100 feet long; the stone and labor of placing, from 21 and 6 per cent., respectively, of the whole amount; while 27 per cent. was the aggregate amount expended for tools, equipment, engineering, and contingencies.

The number and position of the mattresses placed during the year is shown in plan and elevation on Plate XVIII.

Referring to this plate, it will be seen that the crest of the dike has been raised to a nearly uniform height of about 7 feet above low water, a little higher than the top of the bar at the lower end of the line.

The placing of mattresses on the bottom tier was discontinued for a time after it had been extended to a length of about 1,000 feet, but as the current sets strongly across the line of the dike at this point, the bottom began scouring around the outer end of the tier, and work upon it was resumed and continued until its outer end was nearly in its present position. No scour around the end of the mattresses has since been perceptible, as the current at the end of the line sets over toward the water-works, running nearly parallel to the dike.

The effect of the dike in its present form upon the harbor below cannot be estimated until a low stage of river, but a large body of water is turned over toward the Illinois shore, and it seems probable that a good and convenient landing may be found during the lowest navigable stages at any part of the levee above the ferry landing.

A survey of the harbor was made during the latter part of June, with the river about 23 feet above low water. The soundings* taken at that time are shown in black on Plate XVI. They indicate that the bar at the foot of the harbor has moved down stream several hundred feet since 1879, and the low water channel is much nearer the levee.

In constructing mattresses, the brush was placed so as to break joints as much as possible. The small ends of the brush were allowed to project for several feet beyond the ends of the mattresses, to close any gaps left between them when placed, and the bottom layer of brush was so arranged as not to catch upon the ways while the mattress was being launched. The bottom grillage-poles were fastened to the way-pieces with lashings of hide rope until the mattress was ready for launching.

The mattresses were wired or stitched with needles made in accordance with your verbal instructions. These needles were 4 feet 6 inches long, of three-fourths-inch round iron, with a slot near the point, and fitted with a wooden shank, as shown in Plate XIX, Fig. 1. In using these needles the wire is cut into pieces about 32 feet long. A piece is doubled and pulled under a top pole of the mattress at its intersection with a bottom grillage. This position is shown in Fig. 2. The ends are then crossed and thrust down through the mattress, two needles being used as shown in Fig. 3. One end of the wire comes through the mattress on each side of the bottom grillage-pole. Both ends are then taken out of the needles by the workmen underneath, pulled taut, and again crossed, as in Fig. 4. The ends are then pulled up through the mattress as the needles are withdrawn, and fastened with pliers. Figs. 5 and 6 show the position of the ends before and after fastening, respectively.

The length of the mattresses constructed during the year was limited to 80 feet. That size was as large as it seemed expedient to handle in the strong current flowing across the dike. Larger mattresses might successfully have been placed, but in case of accident would have been lost, as it was found by experience that a mattress 80 feet long which had been carried below the dike could be towed back over the line only by a large expenditure of time and taxing the power of the tow-boat to its utmost.

The mattresses were at first constructed upon the floating ways designed for use in improving the Mississippi River at Horsetail Bar, and described in the Report of the Chief of Engineers, United States Army, for 1880, page 1380. Considerable delay was caused by the breaking down of these ways, the weight of the mattresses being greater than they were able to sustain. They were finally disabled and abandoned October 15. Meanwhile the construction of fixed ways on shore near the upper end of the dike had been completed. These ways were made of 3 by 6 inch oak pieces, 42 feet long, set 5 feet apart on rows of 10-inch posts. The ways were continuous and could be used for constructing a single mattress 210 feet long. They were used as described during the fall season, but were undermined and made useless during the winter, and they were entirely reconstructed upon resuming work in the spring. Their inclination was then increased to about 5 on 1 to facilitate launching, and the space between the way-pieces was increased to 7 feet. As the river fell in April a shoal appeared in front of the ways, and their lower ends were extended out 24 feet by oak pieces, resting on posts driven by the pile-driver. The river soon rose again and rendered necessary the extension of the upper ends of the way-pieces, which were lengthened about 12 feet.

After launching, the mattresses were dropped down by the tow-boat alongside a barge loaded with stone, and anchored just above the dike. The barge and mattress were held in position by head and lines leading from the barge to mooring-piles or anchors placed about 1,000 feet above the dike. Mooring-piles were used during the fall season, but they were found liable to be overturned, and they interfered with the handling of the tow-boat. Their use was finally abandoned in favor of anchors, two of which, with an aggregate weight of 900 pounds, were attached to each line, 150 feet

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* Soundings omitted on small scale map.

der the title of "Improvement of the channel of the Mississippi River opposite the city of Saint Louis, Mo."

Money statement.

July 1, 1881, amount available	$60,000 00
July 1, 1882, amount available	60,000 00

R 4.

IMPROVEMENT OF THE MISSISSIPPI RIVER AT OR NEAR CAPE GIRARDEAU, MISSOURI, AND MINTON POINT, ILLINOIS.

The state of affairs existing at this locality before the works were begun is shown on Plate XX, constructed from the survey of 1880. Beginning at Kinney Point, on the Missouri side, the channel crossed over to Devil's Island, followed that shore down to near the foot of the island, and then crossed back to the Missouri shore, spilling over a considerable quantity of water in the direction of Minton Point.

Following the Missouri shore down as far as Cape Rock, the channel then gradually found its way again towards the Illinois shore, its direction here being the resultant of two principal components, viz, the main body of water flowing by Cape Rock, and that flowing by Minton Point. Thus far the location of the channel was favorable for furnishing deep water to the Cape Girardeau landing. Following its general law, its tendency was to leave the Illinois shore somewhere above Wahoo, and, crossing again, to strike the Missouri shore just above Cape Girardeau, and to flow along the front of the town. In its effort to do this it was impeded by the long conical bar which, beginning just below Cape Rock, extended out like an index-finger towards the middle of the river and down in front of Cape Girardeau, leaving deep water inside of it next to the town. Forced out of its natural course the channel was split up into several lines of deepest water, one of them returning to the Illinois shore, and two of them, after being reunited, passing over to the lower extremity of the Cape Girardeau landing. On neither of these lines could more than 4½ feet be carried through at low water, and the width for that depth was so small and the difficulty of following it was so great that practically a considerably less depth was available for navigation. A navigable depth of from 5 feet to 5 feet 4 inches was constantly reported by pilots during the autumn of 1880, at stages from 4 feet to 4 feet 4 inches above low water. This state of affairs was injurious not only to the town of Cape Girardeau, but also to the general navigation interest. In order to reach the town, boats were compelled to approach from below; and in leaving it, to back out. The bar was growing, and threatened to cut off access altogether.

To correct these evils it was necessary to collect all the channels opposite Cape Girardeau into one, and force that one through the long conical bar before described. The thickness of the bar, measured on the line of the proposed channel, was about half a mile. To close the existing channels by a single dike, built opposite the town, would have been to place in the river an obstruction to navigation which for the time being would be a greater nuisance than the bar. Moreover, such a dike would necessarily be expensive and difficult of execution, since it must form a greater obstruction to the flow than a bar half a mile thick. A different solution of the problem was sought, in the belief that it was not necessary to limit the location of the works to the immediate vicinity of the obstacle. In my project of January 12 1881,, I said:

> The comparatively feeble scouring power of the river is due to the dispersion of its waters. In the present condition of the Mississippi a dispersion occurs at nearly every crossing. A dispersion at one crossing reduces the volume and the living force of the channel, and sends down to the next crossing a considerable body of water to contend with instead of aiding it, thus rendering a further dispersion much easier. The dispersion here facilitates the next, and so on. If works be constructed to concentrate the water at any one crossing they cannot fail to have a beneficial effect upon all the crossings for a long distance below. A limit will finally be reached, however, when the benefit will cease to be visible and practical. What that limit is can be ascertained only by experience. It is believed that 3 or 4 miles, which will generally include two or three crossings, is far within the limit, and that it may be assumed with certainty that the works designed for the improvement of one crossing may be distributed over all the crossings for a distance of at least 3 or 4 miles above.

A dike, E F, was accordingly proposed near Minton Point, to run out from the foot of Devil's Island obliquely down stream. The function of this dike was to shut off the flow towards Minton Point, and to send the river down from this place in concentrated shape. The channel issuing from Cape Rock would have no contending stream to force it out of its natural path. It would cross over to the Illinois shore in a compact body, and returning against the Cape Girardeau bar, would strike it as one immense jet of water. It was not expected that this dike alone would complete the removal of the bar. A dike, C D, opposite Cape Girardeau, was designed to complete the work. It was to be constructed after the completion of the work near Minton Point, when it was expected it could be placed without interfering with navigation.

Before the works could be begun a number of changes from the conditions shown on the map occurred, the most important of which were a large increase in the volume of water flowing by Minton Point and a marked increase in the height and size of the bar in the front of Cape Girardeau. The volume flowing by Minton Point was about equal to that in the steamboat channel, and had an equal depth. Heavy caving of the bank was going on near Minton Point. The bar in front of Cape Girardeau had received deposits from 10 to 15 feet in thickness, and portions of it were dry at a stage 18½ feet above low water. At its lowest point, towards its upstream end, there was a depth of but 2½ feet of water at a stage 7.2 feet above low water. The width of the deep water inside the bar next to the landing was diminished to from 200 to 400 feet. These changes did not involve any important modifications of the plan, but they indicated the necessity of its immediate execution.

The work was begun in August last, near Minton Point, the system of construction employed being the same as that used under my direction elsewhere upon the river below the mouth of the Missouri. Within a month after beginning the work its influence upon the Cape Girardeau bar was perceptible.

The primary hurdle E F was still unfinished when the water began to cut through the bar and to wash away the side of it next the town. This action increased as the works progressed, until there was in October a navigable channel over the bar and a strong draught of water down the shore inside. A heavy rise in the river at this time hastened the work of excavation. By the 1st of December the bar had practically disappeared. The desired object had thus been attained by the construction of works located more than 3 miles distant, and without in any manner obstructing navigation. The works opposite Cape Girardeau became unnecessary except as a preservative. In that capacity, however, they were considered important. The prolonged high-water of last autumn and this spring has caused material changes in the location of the channel in the vicinity of Devil's Island and above. Under the new circumstances, the works erected last autumn could not be expected to keep the channel permanently in front of Cape Girardeau, notwithstanding the fact that they caused it to go there. To insure its present location under all circumstances of approach from above, the works opposite the town are required. They were begun in April, but the original plan was modified by leaving out all the secondary hurdles, retaining only the primary hurdle C D. At the end of the year this hurdle had reached a length of 600 feet.

Enlarged sections of the river in front of Cape Girardeau, taken on the line A B, are given on Plate XX. They show the dimensions of the bar at that point at the time the works were planned, at the time they were begun, at the end of the working season last autumn, and at the end of the fiscal year.

These works were under the local supervision of Mr. J. A. Worthen, assistant engineer, from whose report extracts are hereto appended, marked A, to which attention is invited for details.

The expenditures were $43,529.96, of which amount $25,179.84 was specially appropriated by the river and harbor acts of June 14, 1880, and March 3, 1881, and the balance was allotted from the general appropriation for the improvement of the Mississippi River between the Illinois and Ohio rivers.

To complete the original project there remained to finish the hurdle opposite the town and to protect the bank.

Money statement.

July 1, 1881, amount available	$25,179 84
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	25,179 84
Amount (estimated) required for completion of existing project	*41,820 04
Amount that can be profitably expended in fiscal year ending June 30, 1884	42,000 00

REPORT OF MR. J. A. WORTHEN, ASSISTANT ENGINEER.

CAPE GIRARDEAU, MO., *July* 17, 1882.

MAJOR: I have the honor respectfully to submit my annual report of operations for improving the Mississippi River, near Cape Girardeau, Mo., and Minton Point, Illinois, conducted under your direction, during the fiscal year ending June 30, 1882.

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Plate XX is a sketch of the river near Cape Girardeau and Minton Point, showing its general features, channels, and sand-bars as they appeared in September, 1880, river at a 9-foot stage.

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The changes which took place from low water, 1880, to low water, 1881, were such as to excite grave apprehensions for the future of the harbor at this point.

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In August, 1881, the dry bar terminating the projected hurdles near the foot of Devil's Island had entirely disappeared, there being 12 feet of water at the point F, and a small bar had made out from the foot of the island.

The bar above Cape Rock had increased to double its former size, and the long conical bar, which, beginning just below Cape Rock, extended out towards the middle of the river and down in front of Cape Girardeau Landing, had assumed enormous proportions. The dry portion, as shown upon Plate XX, had changed its form, without materially affecting its area, while the lower portion, in front of Cape Girardeau, had received deposits 10 to 15 feet in depth. This latter portion of the bar, about 4,000 feet in length and from 200 feet to 600 feet in width, beginning opposite the mouth of Sloan Creek and extending down past the levee about 500 feet, was then dry, its crest rising to a height corresponding to an 18.5-foot stage of the river.

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*Estimate of last year diminished by amount allotted from funds appropriated for improving Mississippi River between Illinois and Ohio rivers.

Between the bar and the landing was a narrow channel from 200 feet to 400 feet in width, with a depth of 18 feet below the levee, 9 feet at the mouth of Sloan Creek, and 4¼ feet over the head of the bar. The lowest stage of water during the year occurred in September, and was 7.2 feet; the depth of water over the head of the bar was then but 2¼ feet. The only access to Cape Girardeau levee at this time was around the foot of the bar and up this narrow channel.

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Descending steamers were compelled to pass the city and run up behind the bar, backing out as they had come in.

* * * * * * *

The steamboat channel, beginning at the head of Devil's Island, followed along the western bank to near its foot, then crossing to the Missouri shore at Little Floral Creek, followed that shore past Cape Rock into midstream and held nearly a due course to the government light, then on the point of rocks near the southern boundary of the city of Cape Girardeau, touching the Missouri shore again at this point.

The shoalest water in this channel at any time during the season was 6.5 feet, and was found on the crossing from Devil's Island to the Missouri shore at Little Floral Creek.

Leaving the steamboat channel near the foot of Devil's Island was another channel, making a slight detour around the foot of Devil's Island to Minton Point, then gradually finding its way back to the middle of the river, joining the steamboat channel again just below Cape Rock. Although this channel was more direct than the former, and contained the same depth of water, its course not having been definitely marked, was not known to pilots.

Among other changes, the most noticeable was the inroads of the river upon the Illinois shore the entire distance from the mouth of the chute south of Devil's Island to and below the site of the proposed works opposite Cape Girardeau. This cutting of the bank varied at different points from 30 to 50 yards, being greatest at Minton Point, where the erosion was still going on, and continued until the works at this point had advanced for a time and its effects had begun to be felt.

1. LOCATION AND EXTENT OF WORKS CONSTRUCTED DURING THE YEAR.

The fiscal year just closed has been remarkable for its protracted period of high water throughout the Mississippi Valley, and especially in the lower river country.

For three-fourths of the year the river at Cape Girardeau was above a 15-foot stage, and during the months of October and November, 1881, and April, May, and June, 1882, it ranged from 20 feet to 28 feet, a greater portion of the time oscillating between 23 feet and 28 feet. This unprecedented occurrence, frustrating every attempt to predict the rise and fall, or the probable action of the river, has obstructed the progress of the work and greatly increased the cost of construction.

The long and mild winter of unusually high water divided the year into two distinct working seasons.

Following the operations of the fiscal year in their chronological order, the work done during each half year has been described separately.

The plant having been prepared, its transfer from Saint Louis to Minton Point, Illinois, the site of the work first to be constructed, was begun August 10, and with other preliminary arrangements occupied a period of seven days.

* * * * * * *

On the 18th day of August the primary hurdle line E F at Minton Point was located. At this time, the river at a 9-foot stage, about 650 feet at the shore end of the hurdle line was across a dry bar, * * * the crest of the bar corresponding in height to a 10½-foot stage of water.

To complete the hurdle as it advanced and close the gap which otherwise would have existed, it was necessary to make the shore connection by an offset hurdle, * * * leaving the shore 250 feet upstream from the point E, where was found sufficient depth of water to float the pile-drivers, and joining the hurdle line beyond the bar. * * *

On the 19th four pile-drivers commenced driving piles at different points along the bar.

The piles in the hurdle line were in the main driven 6 feet apart, the hurdle to be constructed by hurdling or wattling the brush directly upon the piles.

The brace-piles for receiving the foot of the braces were driven at intervals of about 30 feet, and at distances from the hurdle line which would give the braces an inclination of 45°, as near as might be.

As soon as the pile-driving had advanced to a suitable distance from the shore the footing mattress was begun and carried forward as fast as the piles were driven.

The hurdling was also begun and the several branches of the work moved on together, completing the hurdle as they advanced. The height fixed upon for the construction of this work was that of a 20-foot stage of the river.

On August 31 pile-driving in the primary line had reached a point 800 feet from the angle at G, or about 1,500 feet from the point E at the shore end, when two pile-drivers were removed to secondary hurdles Nos. 2 and 3, and began driving piles in the shallow water at the bar.

The secondary hurdles were located in parallel lines at intervals of 400 feet, and differing from the primary hurdle in having no footing of brush to protect the bed against scour. Their construction has in all cases followed that of the primary hurdle. Work continued in this manner to the 1st of October, when the line of piling in the primary hurdle had advanced into 22 feet of water. It had now reached a point 350 feet beyond the channel, passing around the foot of the island to Minton Point, and was nearing completion, its extremity being about 200 feet from the point F. * * *

At this time the river was at a 12 foot stage, rising rapidly and carrying heavy masses of drift. As it continued to swell, the volume of water seeking the more direct channel to Minton Point was so large and its course apparenty so fixed as to lead to the conclusion that this channel or some modification of it, in contradistinction to that crossing to the Missouri shore at Little Floral Creek, would be the main channel for all stages above a medium, if it did not result in the low-water channel.

The sudden rise of 3 feet in forty-eight hours from October 2 to October 4 sent down upon the hurdle * * * a body of water 25 feet in depth, loaded with drift, and flowing at a velocity not less than 4½ miles per hour. In its effort to follow the channel the current broke through the line of piling about 350 feet from its outer end. The waters rushing through the gap with irresistible force, rapidly eroded the bed, overturned the hurdle, and carried away one section of footing mattress 400 feet in length, which had been constructed, but could not be sunk into position on account of the accumulation of drift.

This erosive action continued along the hurdle line from the point where the mattress had been placed outward, and ceased only when that portion of the line of piling, 500 feet in length, which had been driven beyond this point, was destroyed.

At this time the primary hurdle was 1,756 feet in length, 1,475 feet of which was complete. In consequence of the detour at its shore end, the extremity of the hurdle was a point 1,625 feet from the shore or point E in direct line of location.

Estimating the amount destroyed during the season, the total length of primary hurdle driven aggregated 2,256 feet, and of footing mattress constructed, 2,156 feet.

To continue operations upon the primary hurdle under the difficulties then existing would have been extremely expensive and progress very unsatisfactory, if, indeed, any progress could have been made at all.

For these reasons work upon this hurdle was temporarily suspended, and was not resumed on account of high water, which submerged the hurdle and remained above a 20 foot stage till the close of the season.

While the work of extending the primary hurdle was thus delayed the construction of secondary hurdles Nos. 2, 3, 4, 5, and 6 progressed steadily from the time it was begun to November 19, when operations were suspended for the season.

Pile-driving advanced quite rapidly over the entire area protected by the primary hurdle, and would have completed the system of hurdles had it not been for the high water, varying from a 2.3 to a 28 foot stage, during the latter part of October and the month of November, which maintained a channel along the outer ends of the hurdles * * * from 25 feet to 30 feet in depth, with a current from 4 to 5 miles per hour.

The progress of hurdling was variable, and a greater portion of the time quite slow, as the depth of water was too great to admit of wattling the brush upon the piles, except for a short distance at the shore ends of the hurdles; and the ways upon which to construct curtains were in course of preparation.

The aggregate length of secondary hurdles driven was 5,329 feet, of which 2,101 were completed, except the bracing.

This work was distributed as follows: Hurdle No. 2, 791 feet driven, and complete; hurdle No. 3, 1,014 feet driven, 877 feet complete; hurdle No. 4, 1,292 feet driven, 364 feet complete; hurdle No. 5, 1,392 feet driven, 260 feet complete; hurdle No. 6, 840 feet driven and 600 feet complete.

* * * * * * *

Work was resumed April 20, with the river at a 22-foot stage.

High-water having prevailed a greater portion of the winter, the channels in the vicinity of Cape Girardeau had become fixed, and did not change perceptibly during the second half of the year. * * * *

The damage done to the hurdles at Minton Point by the protracted floods was comparatively slight. The small breach near the shore end ofrthe primary hurdle, which showed itself about the 1st of December, had enlarged to 130 feet; 50 feet of the outer end of hurdle No. 5, which extended into the channel, had gradually worn away; and 384 feet of the chute end of hurdle No. 6, falling within the violent eddy which had formed at the foot of Devil's Island, had been destroyed.

Immediately upon resuming operations the breach near the shore end of the primary hurdle was repaired. While this was being done the river advanced to a 23½-foot stage, again submerged the hurdles and rendered their extension impracticable. April 28 operations at Minton Point were a second time suspended on account of high-water.

On the 27th day of April two pile-drivers commenced driving piles in the primary hurdle line opposite Cape Girardeau, and on the 28th a third joined them. Work upon this hurdle extended over a period of thirty-four days. At no time during this period was the water below a 22-foot stage, and on May 30 it had reached a 26-foot stage, when operations were temporarily suspended. The depth of water in which this hurdle was constructed varied from 21 to 30 feet. The force of the current was almost irresistible.

* * * * * * *

In addition, to these obstructions, severe storms, followed by high winds from the west-northwest, which prevailed for several days at a time, were frequent.

Under these difficulties the rate of progress upon this hurdle was necessarily slow, and the construction rendered much more expensive than it otherwise would have been.

The depth of water being too great to admit of brush being wattled upon the piles, the hurdle has been completed by constructing light curtains upon the ways prepared for the purpose, and launching them into position in a manner explained under "forms of construction."

In extending the hurdle it has been necessary to construct the footing mattress as fast as the piles were driven, and at the same time to brace the piles firmly, thus being better able to guard against losses by keeping as little space as possible between the pile-drivers and the braced hurdle.

As the hurdle advanced the resisting forces increased, and great difficulty was experienced in maintaining its line.

Pile-drivers, placed in position, with four 125-pound anchors for security, were drifted downstream and entirely out of reach of the hurdle. Clumps of piles, consisting of three piles in each clump, driven at intervals of about 200 feet, in a line as nearly as might be parallel to and about 150 feet upstream from the hurdle line, were resorted to for anchorage. These in many cases proved inadequate to withstand the strain brought to bear upon them by the pile-drivers while hoisting piles into the leads and lowering them to the bottom in 30 feet of water.

In some instances all the piles in the clump were broken off above the ground, and in others the tops of the clumps were drifted downstream in such a manner that the piles were pulled up.

Much difficulty has also been experienced in sinking the footing mattress, which was constructed in sections about 130 feet in length and 50 feet in width. Great care is required to maintain the mattress in position while descending to the bottom. It is sometimes the case that the mattress is improperly ballasted by loading the upstream edge too heavily at first, thus causing it to sink more rapidly than the downstream edge; just the reverse of what it should do. This has taken place in two instances, and the current, coming in contact with the upper surface of the mattress, forced it down against the piles after the manner of a curtain. The strains produced by this abrupt stopping of the current were enormous, and in both instances swept away the mattresses and destroyed nearly twice its length of the hurdle driven.

At the close of the year the primary hurdle opposite Cape Girardeau was 600 feet in length.

The hurdles driven and constructed during the year, including repairs, losses, &c., aggregate 8,880 linear feet, of which 2,386 linear feet was in the primary hurdle at Minton Point, 5,329 linear feet in secondaries at Minton Point, and 1,165 linear feet in primary hurdle opposite Cape Girardeau.

The height fixed upon as a standard to which the works were to be carried was that corresponding to a 20-foot stage of the river; but, on account of high water, this standard was deviated from.

At Minton Point the primary hurdle and secondaries Nos. 2 and 3 were carried to a 20-foot stage; secondaries Nos. 4, 5, and 6 were driven at a higher stage of water, and were left as follows: No. 4, at a 23-foot stage; No. 5, at a 24-foot stage; and No. 6, at 26-foot stage. Opposite Cape Girardeau the primary hurdle was complete to a 26-foot stage of the river.

2. FORMS OF CONSTRUCTION.

Regarding the detailed forms of construction very little need be said, as the report of Mr. D. M. Currie, assistant engineer, for 1881 upon this subject was very exhaustive.

The two general forms, the fixed hurdles and the curtain hurdles, have been used throughout the year. During the first half of the year the "fixed hurdle" was used entirely, the brush being wattled upon the piles in depths of water less than 18 feet.

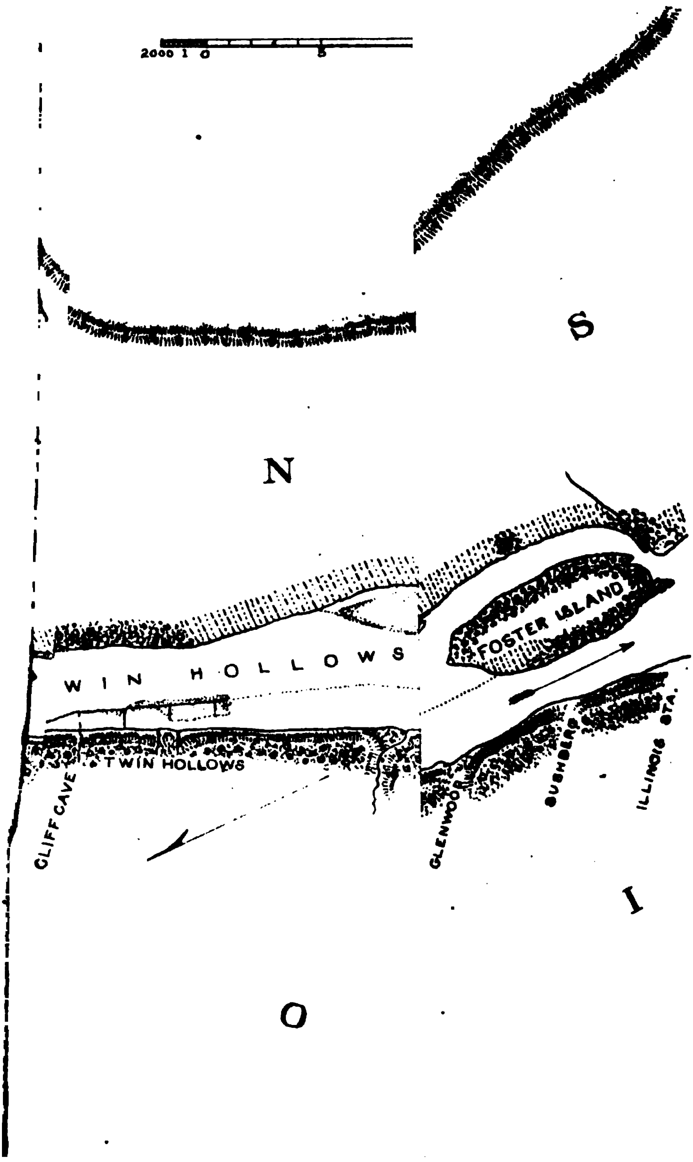
* * * * * * *

The form of "curtain hurdle" used opposite Cape Girardeau, with detailed method r O. H. Ernst, Corps **Plate No. 1.**

M

SAINT LOU

Showing l



of constructing and placing curtain, is shown on Plate V,* in which Figs. 1, 2, and 3 are respectively section, plan, and elevation. When the curtain has been constructed upon the ways it is launched bodily upon the water and floats against the piles. * * * The edge in contact with the piles is made fast to them, and a quarter-line stretched from the up-stream corner of the curtain to the hurdle. * * * This being done, men with pikes or hurdling-forks stand upon the barge and begin its sinking by bearing upon its up-stream edge. * * * The current striking the top surface of the curtain revolves it about its fixed edge into position. * * *

In this method of placing the curtain no stone is required for sinking or securing it in position.

With the top edge fast to the piles, the bottom edge held from sliding along the hurdle by the quarter-line above referred to, and the constant force of the current acting as a lateral component to resist any tendency to move in that direction, the curtain could not or need not be more secure.

* * * * * * *

3. METHOD OF DRIVING PILES.

* * * * * * *

The pile-drivers used during the past year were of the pattern used at Horsetail Bar and other points. The piles driven during the year have been by jet and hammer combined, except in case of repairs, where the piles were driven through a footing mattress or drift-pile, rendering the jet impracticable when the hammer alone was used. But few instances of this kind have occurred, and have not been made distinct note of in connection with the statement below given.

PILES DRIVEN BY JET AND HAMMER.

Time, working hours	2,635
Number of piles driven	2,036
Average depth driven, feet	14.3
Number of piles driven per hour	0.77
Number of feet driven per hour	11.07

The above statement is given not as an example to be followed, but as a means of comparing work done in different localities and under entirely different circumstances.

The past year having been one noted for its unfavorable influences, any standard deduced from a single point of application would lead to an erroneous conclusion as to what could be done in other localities, or under different circumstances in the same locality.

4. PROGRESS MADE TOWARDS COMPLETING THE IMPROVEMENT.

* * * * * * *

Large deposits have been made during the year over the area reclaimed by the hurdles at Minton Point, aggregating 1,100,000 cubic yards.

In addition to this, large deposits have been made along the Illinois shore at Minton Point and below the primary hurdle opposite Cape Girardeau which cannot be estimated, but are as evidently the result of the work as are those lying within the hurdle area.

* * * * * * *

To show more clearly the changes which occurred immediately in front of the city of Cape Girardeau, four sections on the line A B were taken at different times, and are shown with all necessary facts in Figs. 1, 2, 3, and 4 on the map, Plate XX.

* * * * * * *

Very respectfully, your obedient servant,

J. A. WORTHEN,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

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* Plate omitted.

R 5.

IMPROVEMENT OF OSAGE RIVER IN KANSAS AND MISSOURI.

Dike work was done below Tuscumbia at Moore's Flats (40 miles from the mouth) and at Berry's Shoal (51 miles from the mouth).

At Moore's Flats the straightening of the chute, which had been begun at the date of my last annual report, was completed. The dam was extended 120 feet and the training wall about 200 feet. About 3,000 cubic yards of gravel were excavated from the channel, giving it a depth of 3 feet when the Tuscumbia gauge read 2½ feet. This depth was afterwards increased by the action of the river to 4 feet at the same stage.

At Berry's Shoal the training wall was extended 450 feet, and about 1,200 feet was raised and repaired, and 1,897 cubic yards gravel was excavated from the channel.

Dredging was done at Schieler's, Clark's Island, Hoskin's and Kirkman's shoals, all of which are below Tuscumbia, 60 miles from the mouth.

Overhanging trees were removed from the bank and snags from the channel between Grand River and the mouth of the Osage, a distance of about 176 miles. There were removed in all six hundred and ninety-nine trees and four hundred and sixty-three snags. This work was made as complete as the prevailing high stage of the river would permit. It has been of much benefit to navigation. It is intended, however, to go over the same ground at low water. The work will be extended also to Osceola, the head of navigation, 230½ miles from the mouth.

The amount of excavation done at each shoal and the number of trees and snags removed at the different localities are given in the report hereto appended, marked A, of Mr. W. S. Simpson, assistant engineer, under whose direction the work was done.

The funds on hand are believed to be sufficient to complete the work to Osceola. A new supply of these obstructions is to be expected in the future, but how rapidly they will accumulate is a matter of conjecture. It is thought that an appropriation of $5,000 will be sufficient to accomplish all that may be required during the year ending June 30, 1884. The gauges at Warsaw and Tuscumbia were read daily throughout the year. Their records are hereto apprehended, marked B and C respectively.

Money statement.

July 1, 1881, amount available	$31,908 88	
Miscellaneous receipts	35 95	
		$31,944 8
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	20,406 45	
July 1, 1882, outstanding liabilities	49 87	
		20,456 3
July 1, 1882, amount available		11,488 5
Amount that can be profitably expended in fiscal year ending June 30, 1884.		5,000 0

A.

REPORT OF MR. W. S. SIMPSON, ASSISTANT ENGINEER.

JEFFERSON CITY, MO., *July* 1, 1882.

MAJOR: I have the honor to submit the following report of operations for improving Osage River, Missouri and Kansas, for the fiscal year ending June 30, 1882.

On the 17th of June work was commenced at Moore's Flats, in removing the bar and straightening the wall at that place, as per instructions received from you on the 15th of the same month. This work was carried on until September 17, when it was completed.

The work required to be done at this shoal was to remove a large gravel bar some 200 feet in length, 95 feet in width, and at ordinary low-water about 2 feet above the level of the river—and to avoid which the crook in the wall had originally been made—and required the removal of some 3,000 cubic yards of gravel, the extension of both the cross-dam and training wall, the former 120 feet, the latter 800 feet, and the strengthening and rebuilding of some 200 feet of the old training wall.

The means of doing this work was to use scrapers worked by teams, which would remove the gravel until the soft deposit of the bottom of the bar would be reached, when the balance of the required depth would be obtained by laborers with pick and shovel, the excavated material being loaded on barges and the same removed by the steamboat.

The work was greatly delayed during the months of July and August by the excessively hot weather which prevailed during the greater part of these two months, and which rendered it almost impossible to work either men or teams, and also by not being able to get teams or men in the quantity that could have been used to advantage. The dredging was carried on until a depth of 1.5 feet was secured over the place where the bar had been. In addition to the work of removing this bar, the head of the chute was dredged out to a depth of 2 feet below low water.

The work done at this shoal was the heaviest undertaken during the season, and has resulted in a great improvement, at least for the time being, to the navigation of the river. The subsequent rises which have taken place have cut out this channel until now there is not only a straight chute, but also one that when the water has stood at 2½ feet on our Tuscumbia gauge, has showed not less than 3 feet through its entire length. There was also cut and removed from the banks at this shoal thirty-nine overhanging trees, and from the channel sixteen snags.

During the months of August and September, in addition to the work at Moore's Flats, dredging was also done at Scheiler's, Clark's Island, Hoskin's and Kirkman's shoals, and the same class of work commenced at Berry's.

At Clark's Island there were removed, by dredging, 327 cubic yards of gravel; from Scheiler's, 191 cubic yards; from Hoskin's, 61 cubic yards; and from Kirkman's Shoal, 137 cubic yards; but at the latter place we were not able to complete the work at the time on account of the material being too soft to use teams and scrapers, and afterwards it was finished by using the steamboat, drawing the same through the bar and using the wheel to create sufficient current to carry the deposit into deep water.

Berry's Shoal is one that during last year considerable work had been done on in the way of erecting a cross-dam and training wall, but, like many others, required considerable work to be done the succeeding season, for the reason that after a channel has been confined by work of this kind the first rises that occur always serve to scour out the channel at the head of the chute, and the material is then carried down and lodged in such quantities at the foot of the shoal that the current fails to carry it away, and dredging has to be resorted to. It is also found necessary to increase the height of the wall and extend its length until water is reached which is deep enough to allow of a large deposit of gravel before the same will again become an obstruction.

On the 17th of September, the work having been completed at Moore's Flats, the steamboat and party engaged in that work were removed up to Berry's Shoal, and the work of raising, repairing, and extending the training wall at that place commenced. On our way up the river we were detained two days at Kirkman's Shoal, dredging out a bar containing some 220 cubic yards of gravel which had formed at the foot of that shoal, and which was too soft to admit of teams being used in removing it. Work was carried on at Berry's Shoal until October 5, and up to that date 250 feet of the training wall had been raised and repaired, requiring the use of 350 cubic yards of stone and 230 cords of brush. There were excavated from the channel at this shoal 1,879 cubic yards of gravel.

On the 5th of October the river began to rise very rapidly, and by evening of that day we were compelled to suspend all operations, the river a short time afterwards reaching the height of 21 feet above low water. On the 7th of October the steamboat and all the laborers (with the exception of three, who were retained for the care and repair of some of the property) were discharged.

Owing to representations made to me by the owners of the large class of steamboats plying upon the river, that the overhanging timber on the banks of the river above Tuscumbia seriously interfered with the navigation during high water even more than at low, I, on the 28th of October, made application to you to be allowed to commence the work of removing the leaning timber from the banks, beginning at Linn Creek, some 50 miles above Tuscumbia, and working downstream until the river was low enough to resume work at Berry's Shoal. On the 30th of the same month I received your instructions to resume work in the manner indicated, and on the 2d of November left Osage City with steamboat and crew; arrived at Linn Creek the 4th and commenced the work of cutting and removing the leaning timber from the banks the same day, and reached Tuscumbia on the 13th, having worked at nine different shoals, cutting and removing from the banks thereof three hundred and sixteen trees and from the channel fifteen snags, and at one point blasting a large rock from the channel.

November the 14th work was resumed at Berry's Shoal and carried on until the 18th, when the river again rose to such a height that all work had to be suspended.

The work of removing timber from the banks of the river had been of so much benefit to steamboat navigation that I was earnestly requested to continue the work above Linn Creek, some 30 miles, to Proctor's Creek. Accordingly, under instructions from you, the steamboat and crew left Osage City on the 23d, reached Proctor Creek on the 25th of November, and began the work of removing the leaning timber from the banks. Work was done at seven different shoals between Linn Creek and Proctor Creek, and four hundred and fifty-five trees cut from the banks and seventeen snags removed from the channel. Porter's Mills Shoal was decidely the worst one on the river, and there was removed from it alone two hundred and fifty-four trees. The work on this portion of the river was finished as far as it could be done at the stage of water we then had on December 9, and on the 10th of that month work was again resumed at Berry's Shoal, and continued until the 20th, up to which time the wall had been extended 450 feet in all, and raised and repaired for about 1,200 feet, using for this work 890 cubic yards of stone. This about finished the work necessary to be done at this shoal, with the exception of a few points to be cut off, which are too hard for the current to wash out, so as to have the channel the required width.

On the 20th of December the river again rose to such a height that all work had to be suspended, and the season being so far advanced I determined to close operations for the year.

In moving down the river I stopped at Dixon's Shoal and removed from the bank twenty-one trees which had become quite an obstruction to navigation. We reached Osage City December 21, when the steamboat and all the laborers were discharged and the property placed in charge of a watchman for the winter.

On March 23, 1882, I received instructions from you to make preparations to resume operations by removing the leaning timber from the banks and snags from the channel on that part of the river between Warsaw and Tuscumbia. Arrangements were made with the steamer Emma, and we left Osage City on Monday the 27th instant. Owing to the steamer having freight upon her, which she had engaged to deliver at the several landings upon the river, we did not get full control of her until the 29th. We arrived at Warsaw on Friday the 31st, and after an examination we concluded to commence operations about 4 miles above Warsaw, at the mouth of Grand River, some 176 miles from Osage City. The steamer and party were moved up to that point and commenced removing the overhanging timber from the banks. This work has been carried on at intervals up to the present time.

We have been obliged to suspend operations four times, first on April 14, when the river rose, the water standing on our Tuscumbia gauge 10 feet. On the 20th of same month work was resumed and carried on until the 27th, when the river again rose to such a height that we were compelled to suspend all operations. Work was again resumed on the 4th of May and carried on until the 29th, when we were obliged again to suspend all operations on account of another heavy rise in the river, the water standing on our Warsaw gauge at 21 feet and on the Tuscumbia gauge 24 feet above low-water. Work was again resumed on June 14 and carried on up to the present time.

Below you will find a list of shoals, with the number of overhanging trees cut from the banks and snags removed from the channel.

It will be remembered that this is the first time that this river has ever been cleaned out, and although the banks as a general rule are quite stable and are not cut by the current to a great extent, still there were a great many snags in the channel which have been obstructions to navigation for a long time, and which required a great deal of both labor and time to remove.

Number.	Names of shoals.	Distance of shoals from Osage City.	Number of trees cut.	Number of snags removed.
		Miles.		
1	Taylor's Shoal	175	14	2
2	Warsaw Shoals	174	......	2
3	Turkey Creek Shoal	160	47	......
4	Cole Camp Shoal	159	......	2
5	Moss Island Shoal	157	39	......
6	Big Buffalo Shoal	149	13	1
7	Peter Hough Shoal	147	26	2
8	Wigwam	144	91	3
9	Couch's Island	143	67	5
10	Rainy Creek	138	3	4
11	Seth Moore's Island	136	30	27
12	Byer's Island	132	3	13
13	Proctor Creek Shoals	131	53	......
14	Kauffman's Shoal	129	......	8
15	Jim Caphey's	126	......	10
16	Henry Cable's	123	......	2
17	Elizabeth Cable's	122	......	9
18	Osage Iron Works	120	7	2
19	Bolinger Creek	119	8	7
20	Porter's Mills Shoals	110	23	......
21	Cash Williams	108	40	7
22	Milburn Williams	107	......	47
23	Foster's Shoals	105	4	5
24	Boyce's Shoals	103	......	18
25	Salt Shoal	93	......	12
26	Lee Stephens Shoal	90	36	6
27	Wide Ford	86	......	7
28	Round Island	85	33	3
29	Steven's Shoal	79	......	5
30	Big Gravois	77	......	15
31	Little Gravois	68	36	5
32	Churlis Shoal	66	5	91
33	Russel's Shoal	65	3	82
34	A. Brockman	63	......	20
35	Saline	55	6	1
36	Music Shoal	53	6	3
37	Perry's Shoal	50	23	1
38	Kirkman	47	11	......
39	Reynolds	45	5	2
40	Hoskin's Shoal	42	7	6
41	Moore's Flats	38	......	10
42	Sugar Creek	37	3	7
43	White Oak	34	......	1
44	Bois Brule	33	6	5
45	Dixon	27	46	2
46	Shipley	10	5	3
		....	699	463

In closing my report for this year I can confidently say that the work upon the river for the last year has been of great benefit to the navigation of same. We have worked over a distance of 176 miles, and upon the greater part of this there never had been any work of any kind ever undertaken before.

The commerce upon the river has increased to a great extent. In 1873 there was only one steamboat owned upon the river. At the present time there are nine steamboats, with an average of two barges to each boat, which are constantly plying upon the river.

There has not been less than 2½ feet of water in the channel on the first 150 miles since last October, and at that depth for only a few days at a time.

The navigation of the river was not interrupted at all last winter by ice, and boats were kept constantly employed during the winter months.

The heavy rises in the fall and first part of winter were very destructive to the raft interest, and caused the almost total suspension of this kind of navigation on the lower part of the river, but at the same time it increased the steamboat navigation over double that it had been in former years.

The works between the mouth and Tuscumbia have stood remarkably well, and in every place have done all that has been expected of them, and when several times the water stood on our Tuscumbia gauge 2½ feet above low water there was at every shoal below that place where the channel had been contracted, except one, a ruling depth of over 4 feet,* the exception being the channel at Kirkman's Shoal, which was owing to a boat having grounded by not keeping in the channel. In sparring her back again, they cut up the chute and formed lumps of gravel to such an extent that the current has never been able to carry them out, and, owing to the continued high-water, we have been unable to remove same.

I would respectfully recommend that another season that an appropriation be asked for the purpose of continuing the removal of snags from the channel and overhanging timber from the banks as far up as Osceola.

The Osage River is now reached by railroads at two points, whose termini are at its banks, and which do not cross it, the first at Warsaw, where the road from Sedalia ends. This road is almost entirely supplied by the products of the Osage Valley between Osceola and that point, a distance of 78 miles. And on this section the raft interest is very large, and the number of railroad ties and lumber which has been rafted down the river and shipped from that point, has been quite large. And, again, a branch of the Missouri Pacific Railroad from Jefferson City, which has been built in the last year, taps the river at the mouth of the Little Gravois, a distance from Warsaw of 95 miles. This section of the river has supplied this road with nearly all of its trade.

This section has been very thoroughly cleaned out, and for a number of years will require but a very little work of this kind to be done on it. Below the mouth of the Little Gravois, the trade of the river is almost entirely done by steamboats, and the works which have been built will always require a small appropriation for the purpose of repairs and removing of snags which may lodge in the several chutes where the river has been contracted.

Respectfully submitted.

W. S. SIMPSON,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

Statement of the commerce upon the Osage River from July 1, 1881, *to June* 30, 1882.

Articles.	Quantity.	Value.
	Tons.	
991,013 railroad ties	....	$396,405
3,100,000 feet walnut logs rafted	....	93,000
225,000 feet walnut lumber boated	....	9,000
3,800,000 feet oak logs rafted	....	76,000
50,000 feet oak lumber boated	....	1,250
281,000 pine shingles	....	702
10,000 laths	....	15
286,150 feet pine lumber	405.5	5,723
130 cords wood	195.0	325
81½ tons hay	81.5	1,630
66½ tons baryta	66.5	2,660
283 hogs	....	3,396
326 barrels flour	32.0	2,119
192,063 bushels wheat	5,762.0	240,078
9,772 bushels corn	254.0	7,329
1,191 bushels oats	21.0	505
2,211 tons miscellaneous freight	2,211.0	....
Total	9,028.5	840,228

The following steamboats have been employed on the river during the year: Phil E. Chappell, Aggie, Tuscumbia, Coleman, Sport, Carrie, Jim Watson, Emma, John L. Rhodes, D. Hurlburt.

I have been unable to get the number of trips made by each boat, as some have changed owners and others have left.

The Chappell made the trips to Osceola. The others have been at different times as far up as Warsaw. The Rhodes made only one trip, and that as far as Tuscumbia.

The average charge per ton for freight between Tuscumbia and Osage City has been about $4.

Very respectfully, &c.,

W. S. SIMPSON,
Assistant Engineer.

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* Channel depth at low-water not observed. River has not fallen below a 2½-foot stage since November. Previously to that it was below that stage nearly three months.

B.—*Record of gauge at Warsaw, Mo., for the fiscal year ending June* 30, 1882.

Days.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	8.00	0.10	—0.60	9.00	3.00	4.00	3.70	3.10	15.00	4.10	2.90	17.00
2	6.00	0.10	—0.60	12.50	3.20	3.80	3.60	3.10	14.00	3.80	2.80	15.80
3	4.10	0.10	—0.60	17.20	3.00	3.60	3.50	3.00	11.00	3.60	2.70	14.70
4	3.00	0.00	—0.60	18.40	2.80	3.40	3.40	3.00	8.00	3.40	2.50	14.00
5	2.60	0.00	—0.60	15.50	2.60	3.20	3.30	2.90	7.00	3.20	2.80	13.40
6	2.30	—0.10	—0.60	10.30	2.40	3.10	3.20	2.90	7.00	3.10	4.90	12.00
7	2.10	—0.10	—0.60	6.00	2.40	3.00	3.10	2.90	7.00	3.00	4.20	9.50
8	1.80	—0.10	—0.60	4.00	2.00	2.90	3.00	3.00	7.09	3.40	3.50	6.70
9	1.60	—0.20	—0.60	11.80	2.00	2.80	3.10	3.10	8.08	4.80	3.30	4.50
10	1.40	—0.20	—0.60	17.00	2.00	2.70	3.30	3.10	10.07	5.90	3.20	3.70
11	1.20	—0.30	—0.50	14.00	3.00	2.60	3.30	3.20	13.00	7.30	4.30	3.00
12	1.10	—0.30	—0.50	8.00	10.00	2.50	3.40	3.20	12.07	8.50	4.20	3.40
13	1.00	—0.40	—0.60	6.50	12.10	3.60	3.90	3.10	12.00	8.00	3.70	6.30
14	0.90	—0.50	—0.60	5.40	12.30	4.70	6.00	3.10	11.00	6.70	3.30	7.20
15	0.80	—0.50	—0.60	4.80	12.20	5.20	7.20	3.00	10.05	5.30	3.00	6.00
16	0.70	—0.50	—0.70	4.50	11.50	4.60	7.20	2.90	9.06	4.00	2.70	5.90
17	2.00	—0.60	—0.70	4.00	10.70	4.00	6.10	2.80	8.08	3.80	2.50	5.40
18	2.50	—0.60	—0.70	11.00	15.00	3.50	5.30	2.70	8.00	3.10	2.30	6.80
19	2.40	—0.60	—0.70	12.50	19.00	3.30	4.70	19.00	7.03	2.90	2.20	7.80
20	2.00	—0.60	—0.70	12.50	20.00	3.20	4.10	26.00	6.02	2.70	2.10	7.40
21	1.70	—0.60	—0.70	12.60	21.00	9.50	4.00	31.00	5.04	2.60	2.00	8.60
22	1.50	—0.60	—0.70	12.60	15.00	11.40	4.30	35.00	7.00	2.50	1.90	9.50
23	1.30	—0.60	—0.70	12.00	11.40	13.00	4.10	32.50	7.05	3.00	1.80	10.60
24	1.20	—0.60	—0.70	10.00	7.90	11.60	3.90	30.50	6.08	4.00	3.50	11.00
25	1.00	—0.60	—0.70	7.60	6.70	8.30	3.80	28.00	5.02	4.80	3.00	10.60
26	0.80	—0.60	—0.70	6.00	5.70	7.60	3.70	23.00	4.05	5.50	9.20	10.30
27	0.60	—0.60	—0.70	5.00	5.00	6.00	3.60	20.00	4.08	4.70	17.00	9.30
28	0.40	—0.50	—0.70	4.30	4.60	5.20	3.50	16.50	4.07	4.00	21.00	7.00
29	0.30	—0.50	—0.60	3.80	4.40	4.60	3.50	....	5.03	3.50	21.70	5.80
30	0.20	—0.50	9.00	3.40	4.20	4.20	3.30	....	4.08	3.20	19.00	4.50
31	0.10	—0.60	....	3.00	....	3.90	3.20	....	4.05	....	18.00	......

C.—*Record of gauge at Tuscumbia, Mo., for the fiscal year ending June* 30, 1882.

[Zero of gauge, low-water of 1854.]

Days.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	10.55	0.20	—0.45	1.70	4.05	5.65	5.25	4.20	20.00	6.10	4.70	20.50
2	10.30	0.10	—0.45	9.65	3.70	5.35	4.90	4.10	17.10	5.90	4.15	18.00
3	8.45	0.00	—0.45	13.60	3.60	5.10	4.55	3.90	16.00	5.60	3.85	17.20
4	6.65	—0.05	—0.50	16.95	3.65	4.75	4.25	3.70	14.40	5.15	3.60	16.10
5	5.00	—0.15	—0.50	18.00	3.55	4.50	4.05	3.65	12.90	5.75	3.50	15.15
6	3.45	—0.20	—0.55	17.55	3.40	4.35	3.85	3.60	10.40	5.50	3.70	14.45
7	2.90	—0.25	—0.55	14.60	3.05	4.30	3.75	3.70	8.60	5.25	4.20	13.20
8	2.55	—0.30	—0.55	10.70	2.85	4.00	3.70	3.95	7.50	5.10	5.40	11.95
9	2.35	—0.35	—0.55	14.20	2.60	3.90	3.80	3.85	8.30	5.10	5.65	9.40
10	2.05	—0.40	—0.45	16.40	2.40	3.65	4.00	4.10	9.25	3.95	5.05	7.30
11	1.70	—0.40	—0.40	17.95	2.35	3.50	4.25	4.30	12.00	5.90	4.70	6.05
12	1.50	—0.45	—0.40	17.60	2.40	3.40	4.30	4.30	13.60	7.40	5.15	4.95
13	1.20	—0.45	—0.45	13.10	6.80	3.40	4.90	4.50	13.85	8.80	5.65	4.50
14	1.00	—0.45	—0.45	9.50	11.90	4.85	6.00	4.30	13.35	9.15	5.70	4.50
15	0.90	—0.50	—0.40	7.90	12.30	6.20	7.70	4.10	12.60	8.60	4.85	7.85
16	0.70	—0.50	—0.45	7.35	12.35	6.45	8.50	3.95	11.80	7.55	4.20	8.30
17	0.55	—0.55	—0.45	6.50	12.00	6.30	8.80	3.80	11.10	5.65	3.85	7.15
18	0.65	—0.55	—0.50	6.60	15.60	5.50	8.35	3.70	10.35	4.80	3.50	6.40
19	0.65	—0.55	—0.50	11.60	20.00	5.00	7.40	13.80	9.65	4.30	3.25	6.55
20	2.55	—0.60	—0.50	12.60	23.50	4.90	6.50	26.50	8.80	3.95	3.10	8.00
21	2.45	—0.60	—0.50	12.85	24.00	5.60	5.90	30.00	8.20	3.70	2.90	8.75
22	2.10	—0.60	—0.55	12.90	22.50	9.30	5.40	35.00	8.25	3.85	2.75	9.20
23	1.60	—0.60	—0.55	12.85	18.50	11.80	5.40	37.50	8.35	5.10	2.55	9.65
24	1.35	—0.60	—0.55	12.60	14.85	13.40	5.65	35.00	8.80	5.15	2.70	10.40
25	1.10	—0.60	—0.60	11.55	10.80	13.30	5.75	34.00	8.25	5.10	3.10	11.35
26	0.95	—0.60	—0.60	0.60	9.'0	12.00	5.55	32.00	7.40	6.40	10.80	11.40
27	0.80	—0.60	—0.60	8.20	7.10	10.00	5.25	30.00	7.05	6.80	18.00	11.30
28	0.70	—0.60	—0.50	7.00	6.60	8.30	4.90	24.50	6.75	6.45	23.25	11.20
29	0.65	—0.65	—0.45	6.00	6.15	7.00	4.70	....	6.60	5.75	25.00	10.50
30	0.45	—0.50	—0.20	5.50	5.80	6.80	4.50	....	6.80	5.10	24.25	9.35
31	0.30	—0.40	....	5.10	....	5.80	4.40	....	6.50	....	22.50	......

SURVEY OF OSAGE RIVER, MISSOURI, FROM TUSCUMBIA TO MOUTH OF RAINEY CREEK.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., April 21, 1881.

GENERAL: I have the honor to transmit, herewith, tracings* of the maps of the Osage River between the mouth of Rainey Creek and Tuscumbia, ten sheets of plan and one sheet of profile, surveyed last autumn by Mr. S. E. McGregory, assistant engineer, under the authority contained in your letter of July 8, 1880. The report of Mr. McGregory is also transmitted.

Upon each sheet of plans is a portion of the river platted upon a scale of $\frac{1}{10000}$. Upon the same sheet a separate plan of each shoal is given upon a scale of $\frac{1}{2500}$. The profile shows the bottom of the river in the channel, the elevation of both banks, and the low-water slope, the zero of the profile being the low-water line at Tuscumbia. The horizontal scale of the profile is $\frac{1}{10000}$ and the vertical scale is 1 inch to 6 feet. Distances are given in miles from Rainey Creek upon both plan and profile, being marked upon the former in red ink and upon the latter in black.

The length of river covered by the survey is 79½ miles. In this distance it receives but one important tributary, the Niangua River, which enters it from the south—see sheet 4—about 30½ miles below Rainey Creek. The Niangua is reported by Mr. McGregory to be "a stream of considerable size, which is fed by perennial springs, and from which the Osage derives nearly one-half of its supply during low-water."

The fall between Rainey Creek and the Niangua is 24.08 feet in 30½ miles, or 9.47 inches per mile, and between the Niangua and Tuscumbia 41 feet in 49 miles, or 10.04 inches per mile. This fall is not by any means uniform. The river consists of a series of deep lakes or pools, upon which there is practically no fall, separated by shoals upon which all the fall is concentrated.

In the pools the movement of the water is imperceptible and the velocity cannot be accurately measured. The shoals are usually composed of coarse gravel, through which a large portion of the water finds its way by leakage. The area of cross-section of the stream has here to be estimated. These circumstances render it very difficult to measure the low-water discharge of the river. No new discharge observations were made by Mr. McGregory. The discharge at ordinary low-water was estimated by Mr. Wm. M. Gordon, in 1875, to be 350 cubic feet per second, though the discharge actually measured by him at Alfred's Shoal, above Rainey Creek, was but 64 cubic feet per second (see Annual Report of Chief of Engineers for 1875, page 496). In an unpublished report on file in this office, dated July 24, 1873, upon the survey of the river below Tuscumbia, the discharge is given by Mr. A. H. Blaisdell, assistant engineer, at 277 cubic feet per second. It is quite certain that the low-water discharge does not exceed 300 cubic feet per second, and that, considering the porous character of the soil, a much less quantity is available for purposes of navigation.

The range of the Osage is 39½ feet. At high-water it is a vast body of water flowing with the great velocity due to a slope of about 10 inches to the mile, and capable of moving heavy gravels and modifying its bed with great facility.

Between Rainey Creek and Tuscumbia there are fifty-six shoals which are now prominent, or one to every 1.4 miles. Of these, thirty-three have been the subject of "improvement" by the State of Missouri. The works are shown upon the maps. What the order of construction of these works was and what were the results at first obtained by them are points about which I have no information. They seem to have been designed to concentrate the flow over the shoals into a narrow space, with a view to excavating a permanent channel through them. Many of the works are badly located, if they are to be judged by the state of affairs now existing, and some of them are in a dilapidated condition; but their universal falure is due, perhaps, not so much to these causes as to the fact that they were designed to accomplish an impossible task.

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*Tracings not printed.

A list of the shoals and their distances below Rainey Creek, and the elevation of the water surface at the head and at the foot of each shoal, is given in tabular form in Mr. McGregory's report.

An examination of the plan shows that these shoals are not found at places where the low-water width is unusually great. On the contrary, the width is usually less than in the pools. The stream is contracted both horizontally and vertically, and the shoals therefore constitute true natural dams. The profile shows the fifty-six shoals acting in that capacity. Above each shoal is a pool with horizontal, or nearly horizontal, surface, and below is a similar pool.

There is an important distinction between the Osage River at low stage as a flowing stream, and as a body of navigable water. Its dimensions in the first respect are dependent upon its drainage area and the annual rainfall, and these cannot be altered by the engineer. Its dimensions in the second respect are dependent upon its reservoir capacity, and this may be enlarged or diminished by engineering works. As a flowing stream alone it is an insignificant creek, discharging less than 300 cubic feet of water at its mouth. As a body of navigable water it is at this time a series of capacious lakes, but the communication between the lakes is difficult.

These fifty-six natural dams, or their equivalent, are a necessity of the river if its present capacity as a body of navigable water is to be retained. The removal of any one of them will lower the surface of the pool above. Irregularities of the bed which are now deeply submerged will be brought nearer to the surface and new shoals will be developed. The removal of these will develop others and will reduce the depth upon the shoals already improved, bringing them again into prominence. At each locality there will thus be a long series of alternate improvement and deterioration.

If the range of the Osage were moderate, and there were no tributaries to disturb this process by the introduction of new supplies of gravel, it might be practicable in the course of time, by a vigorous application of dredges, wing-dams, and training walls, to bring the entire river to the condition of a canal with uniform cross-section and uniform slope, and of uniform depth throughout. In that condition its navigability would have reached the highest state of perfection of which the free-flowing channel is capable. The body of water, however, would be a minimum. The lakes would all be drained, and would be replaced by a stream of which the width would not exceed 80 feet and the depth 2 feet. The existence of gravel-bearing tributaries and the high-water character of the stream will prevent the realization of such an ideal river; some parts will always be deeper than others. As this ideal, however, is the highest result at which we can aim with a system of open-channel improvement, the supposition that it has been accomplished will allow the merits of the system to be judged under the circumstanc most favorable to it.

A stream 80 feet wide and 2 feet deep will not be adapted to the commerce of the Osage Valley, either present or prospective. Statistics o the commerce of the river during the six months ending December 31 1880, have recently been collected under my direction by Mr. W. S Simpson, assistant engineer, and have been made as complete as practicable. They are as follows, viz:

Carried by boat.

Articles.		Quantity.	Value.	Weight.	Freight charges
				Tons.	
Wheat	bushels	128,350	$128,350 00	3,850	$7,700
Flour	barrels	600	3,600 00	59	118
Baryta	do	341	6,885 00	153	306
Brick		190,000	950 00	388	776
Miscellaneous		Unknown.	Unknown	405	810
Pine lumber	feet	100,000	2,000 00		
Wood	cords	485	1,212 50		
Total value			142,997 50		

Rafted.

	Valued at–
Railroad ties, 709,805	$283,92
Oak logs, 2,000,000 feet	20,00
Walnut logs, 300,000	7,50
Total value	311,42

These statistics show the rafting interest to be about double the boating interest. They cover a period during which the low-water seaso occurs, and it is probable that if an entire year were included the relative proportions of these interests would be altered. But it will be safe I think, to regard the rafting interest as at least equal to if not greate than the boating interest. To reduce the Osage from a width of 40 feet to 80 feet throughout its length will be an injury to that interes which will not be mitigated by the increased depth upon the shoals.

A depth of 2 feet will enable the few small steamboats now employe to navigate the river for a larger part of the year, carrying passenger the mail, and small quantities of freight, but it is evident that the dept is not well adapted to the cheap transportation of heavy freight. Th amount of commerce now existing, as shown by the statistics, is n measure of what this stream will one day be called upon to carry. It i to its prospective rather than to its present commercial importance tha the improvement should be adapted. The valley possesses great store of iron, coal, lead, zinc, marble, and other useful minerals. A 2-foo navigation will not aid in any material degree to develop these resources, and after they are developed it will be regarded as absolutel insufficient.

The works required to give this depth are in direct conflict with tho required to give a greater depth, viz, locks and dams. They result i reducing the volume of navigable water, while it should be increase They constitute solid obstructions in the bed of the river, rising to height of 3 feet 6 inches above low-water, which it will be necessary t remove before the present capacity of the stream can be restored. Whi of doubtful utility for the present needs of commerce—supposing them t be successful—they are a positive injury to the river, taking into ac count its future necessities. It is hardly necessary, in view of the foregoing, to inquire what the effect of draining these lakes would be upon the sanitary condition of the country.

The slack-water improvement of this stream is, I think, only a question of time. It will probably not be seriously undertaken until after the improvement of the Missouri River, into which it empties, and in which there is now a channel depth of but 3 feet. That day may be far distant. It probably is. But in these preliminary operations upon the river it should not be lost sight of. Nothing should be done now which will render that work more difficult or more costly.

While the final results of removing all the shoals are thus seen to be nything but desirable, there are several reasons why that plan should lways have its partisans among those immediately interested in the mprovement. It permits immediate results to be obtained from small ppropriations, and it results in deepening the water at the place where t is first applied. The latter fact causes the casual observer to believe hat, if universally applied, it will universally deepen the water. Con-idering only the present and disregarding the future, he is gratified to nd a depth of 2 feet at a spot where he is accustomed to find but 6 nches, and he naturally urges a continuation of the work. Present enefit having a more powerful influence upon his mind than future in-ury, it might happen that, even after the final results of the system are ully comprehended by him, he would still urge its prosecution.

The river itself possesses a power which will probably prevent the nfliction of such evils upon it. Seen at a low stage, it would seem in-apable of modifying its own bed to such a degree as to neutralize the vork of excavation in a short time. A very different state of affairs xists, however, at high-water. The gravel moved at such times finds convenient lodgment in the narrow cuts provided by the dredge, and hey are promptly filled up. The same thing occurs, though to a larger egree, if there are wing-dams and training-walls, the result being that hese works tend rather to increase than to diminish the height of the hoal. The removal of all the shoals can therefore only be attained, if t all, by renewed and persistent efforts with the dredge, and at heavy nal cost. The temporary deepening of the water at a few of them is nly a delusion.

As wing-dams and training-walls, combined with dredging by means f scrapers, have been applied to a portion of the Osage by the gov-rnment, it is proper to notice the circumstances under which that has een done, and to make inquiry as to the results obtained.

The conclusion that no permanent improvement of the open channel practicable was reached by my predecessor several years ago. In his nnual report for 1875 (see Annual Report of Chief of Engineers, 1875, ge 489), he says:

> Learning by experience that the Osage River could not be permanently improved wing-dams and training-dikes, under date of September 1, 1874, with the approval the Chief of Engineers, I instructed my assistant, Mr. William M. Gordon, to sur- y the river from Osceola or Roscoe to Tuscumbia, to ascertain by actual and accurate rvey the practicability and cost of a lock and dam navigation.

The report of this survey, which was completed only to the mouth of iney Creek, was dated February 11, 1875, and gives a brief sketch of the story of the operations up to that time. (See Annual Report of Chief Engineers, 1875, page 490.) Upon the statement of facts therein esented, the appropriations for the river ceased, and were not renewed til 1878, when, by the act of June 18, an appropriation was made of 0,000. A portion of this was applied to surveying the upper river from

Ottawa, Kans., to Osceola, Mo., and the balance applied to the improvement of the lower river, below Tuscumbia, by means of wing-dams and training-walls, and dredging as before.

In his annual report for 1879, Colonel Simpson says:

> No estimate of the cost of completing the improvement upon the system practiced hitherto has been or can be made.

(See Annual Report of Chief of Engineers, 1879, page 1045.)

The system of open channel improvement was applied by him below Tuscumbia during the seasons of 1878 and 1879, and was continued under my direction during the season of 1880. By the 30th of June, 1880, temporary improvement had been effected upon the greater part of the shoals below Tuscumbia. The obstructions at Shipley's and Burd's shoals had, however, been renewed, and at five other shoals no work had been done.

The appropriation June 14, 1880, being more than sufficient to provide for the works required during the year at these places, the present survey was undertaken in August, with a view to preparing plans of improvement for the portion of the river above Tuscumbia. It was supposed at that time the improvement was less temporary than it really was, and that it would be practicable to carry a draught of 2 feet through to Tuscumbia after the execution of the works contemplated at the shoals above referred to. The low-water season of last autumn, however, developed a number of new shoals, upon which the depth was less than 2 feet, thus confirming the opinion of my predecessor.

The slope of the river below Tuscumbia is much more gentle than that above, being but 25 feet in 60 miles, or 5 inches to the mile. The steps in the hydraulic stairway are, therefore, much lower, and can be replaced by an inclined plane much more easily than above Tuscumbia. The success of the system below Tuscumbia would be no guarantee of its success above, while its failure there is evidence that the failure above would be still more emphatic.

The conclusions are—

1st. It is believed to be impracticable to make a continuous improvement by means of dredging, or by wing-dams and training-walls, either with or without dredging.

2d. If practicable, the result would be of doubtful utility to the present commerce of the valley, and would not adapt the river to its prospective commerce.

3d. The construction of stone dams and training-walls in the bed o the stream is, when taking into account its future necessities, an injury to it.

4th. A lock and dam improvement is the only means of permanently deepening the channel, and the time for seriously undertaking tha work seems not to have arrived.

It is accordingly recommended that operations upon the Osage b limited for the present to the removal of overhanging trees from th banks, and of such snags and bowlders as may be found in the channel and that the funds now available, $15,000, exclusive of the appropriatio of March 3, 1881, be applied to carrying that work as far as the mean will permit, working up stream from Tuscumbia.

Very respectfully, your obedient servant,

O. H. ERNST,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. S. K. M'GREGORY, ASSISTANT ENGINEER.

ENGINEER OFFICE, U. S. ARMY,
Saint Louis, Mo., March 22, 1881.

CAPTAIN: I have the honor to submit my report, together with maps and profile of urvey of Osage River made in the months of August, September, and October of last year, under instructions from you, as follows:

* * * * * * *

This survey of the Osage River covers a section not embraced in previous surveys nd completes the survey of the whole river from Ottawa, Kans., to the mouth.

The party was organized at Jefferson City and transferred by government boat to Tuscumbia, which was reached August 25, 1880. As first organized, the party consisted of eleven persons, but as the difficulties increased—occasioned by high-water nd sickness in the party—others were added; but at no time did the number reach the maximum allowed in your order.

The survey up stream from Tuscumbia was commenced August 26, and proceeded without interruption until September 3, when a heavy rise in the river made it diffiult to move our flat-boat up stream against the increased current without steam ower. The water at that time covered all the open spaces along the shores, and the urvey had to be continued back in the timber and brush upon the high banks, making progress very difficult and slow. Upon being made acquainted with this condition of things, you ordered the party transferred by steamboat to Rainey Creek, which was reached September 11.

The survey down stream from Rainey Creek was commenced September 13, and progressed more rapidly, being interrupted only by sickness in the party.

The survey down stream closed with that portion made up stream on October 15; ut as a portion of the up-stream survey had been made during a temporary rise in he river, it was deemed advisable to continue the line further down the river, to give he low-water shores and connect special surveys and examinations of shoals with previous survey.

The field-work of survey was completed October 18, and by your orders the party as transferred to Jefferson City and discharged.

The work upon the maps (ten in number) and profile was commenced October 23 nd is now completed.

The commercial importance of the Osage River has been fully discussed in reports f former surveys and nothing more need be said upon that subject.

Levels were run the whole distance, connecting with Gordon's benches at Rainey reek and Blaisdell's at Tuscumbia.

The total length of this section is 79¼ miles, with a total fall of 65.08 feet. In Mr. ordon's report he gives the total fall, as quoted from State engineer's report, as 65 et.

A line of soundings was taken the total length of the survey along the center of the hannel, and cross-sections made upon all the shoal places having less than the required depth at low-water.

The maps of the river are drawn on a scale of $\frac{1}{10000}$ and the shoals or special surveys on a scale of $\frac{1}{2000}$.

The profile shows the bottom of the river and elevations of both banks, low-water ope of the river, and the low-water line at Tuscumbia, which is zero of the profile. he following is a tabular statement giving the names and number of the shoals, e distance from Rainey Creek to each shoal, and the elevation of the low-water ope at the head and foot of each shoal. The distances are given in miles from iney Creek, and are marked in red ink on the map, and corresponding distances in ack ink on profile.

ps, No. of sheet.	No. of shoal.	Name of shoals.	Distance in miles from Rainey Creek.	Elevation of low-water slope at head of shoal.	Elevation of low-water slope at foot of shoal.
1	1	Rainey Creek	0	65.08	63.15
	2	Seth Moore	1¼	63.15	62.81
	3	Byers	3¼	62.81	61.00
	4	Proctor's	4¼	61.00	59.34
	5	McFarlin's	5¾	59.34	58.09
2	6	Rapids	6¾	58.07	55.94
	7	Coffman's	7¼	55.85	54.75
	8	Driscoll Island	9¼	54.40	54.83

Maps, No. of sheet.	No. of shoal.	Name of shoals.	Distance in miles from Rainey Creek.	Elevation of low-water slope at head of shoal.	Elevation of low-water shoal at foot of slope.
No. 2	9	Wilson's	10¾	54.32	52.75
No. 3	10	Henry Cable	12¼	52.67	51.83
	11	Sam Cable No. 1	14	51.76	51.45
	12	Sam Cable No. 2	14½	51.45	51.43
	13	Peter Cable	15¾	51.43	49.56
	14	Bollinger Creek No. 1	16½	49.54	48.34
	15	Bollinger Creek No. 2	17	48.34	47.22
	16	Bollinger Creek No. 3	17½	47.22	47.00
	17	Carroll's	18	47.00	46.86
No. 4	18	Porter Mill	22½	46.86	45.86
	19	Foster Island	24½	45.79	43.88
	20	Cash Williams	25¾	43.86	41.98
	21	Milbourne Williams	27¾	41.92	41.74
	22	Austin Cranes	30	41.73	41.14
No. 5	23	Linn Creek	31	40.98	38.15
	24	Town	32½	38.11	36.93
	25	Friar Ear No. 1	33	36.93	35.60
	26	Friar Ear No. 2	33½	35.60	35.54
	27	Foley Island	35	35.54	34.14
	28	Big Kinsile	37	34.11	31.28
	29	Little Kinsile	38	31.28	30.85
No. 6	30	Dr. Little	39½	30.76	29.70
	31	Salt Island No. 1	41¼	29.70	27.18
	32	Salt Island No. 2	42½	27.18	27.18
	33	Au Glaize	44	27.09	25.65
	34	Rays No. 1	45¼	25.65	24.91
	35	Rays No. 2	46	24.91	24.50
No. 7	36	Wash. Lamb No. 1	48½	24.50	24.12
	37	Wash. Lamb No. 2	49½	24.12	24.07
	38	Wide Ford	50¼	24.07	23.37
	39	Round Island	51¼	23.37	20.93
	40	Bart Stevens	52½	20.93	19.8
	41	Widow Stevens	55½	19.80	19.3
No. 8	42	Big Gravois No. 1	56¾	18.94	18.1
	43	Big Gravois No. 2	57¾	18.11	17.4
	44	Big Gravois No. 3	58	17.40	16.4
	45	Stephen Howser	59¾	16.47	14.4
	46	Middle Howser	61	14.40	13.7
	47	Lower Howser	61½	13.74	13.0
	48	Easter's	62¼	13.08	12.3
No. 9	49	Little Gravois No. 1	67¾	12.14	11.3
	50	Little Gravois No. 2	68½	11.30	10.7
	51	Granny's Island	69½	10.66	7.9
	52	Russell Island	71½	7.94	7.3
	53	A. Brockman	74½	7.32	5.7
No. 10	54	Sim. Brockman's	76	5.61	3.5
	55	Bed Quilt Shoal	77	3.50	3.2
	56	Tuscumbia Shoal	78	3.17	0.

This portion of the Osage River at low-water is nothing but a succession of deep lake or pools, connected by one or more shallow streams of running water. It has bee known to rise 39½ feet above low-water mark at Tuscumbia. At high-water its char acter is entirely changed, its average fall being .82 of a foot per mile; it becomes rapid, resistless torrent, and has been known to pour such a flood into the Missouri a to cause that river to back up as far as Jefferson City. At such times much of th Osage Valley is under water.

There has been considerable money expended by the State of Missouri in improvin many of the shoals on this section of the river; but as the work was done a long tim ago, and has received no attention in the way of repair since, it is in some places i a bad condition, the dams being broken, either accidentally or intentionally, and othe wise injured by the combined action of the floods and floating ice. The stones remai ing in place are of large size, and well bedded in the surrounding gravel, and m serve as a good foundation or anchorage for new work, if the location of the dik and dams is such that they can be utilized.

Fully one-third if not one-half of the water finds its way through the dikes and dam in numberless little streams, instead of finding its way down the low-water chann intended for it; also a large percentage sinks in the coarse gravel composing the ba and comes up below in the form of numerous springs. This leakage can only b stopped by spreading upon the up-stream slope of the dams and bars a finer mater than that of which they are composed, up to the low-water line.

Rock can be obtained on the river banks near all the shoals and in many places without the trouble and expense of quarrying it.

The bars or shoals are usually found immediately below the mouth of some creek or branch that flows into the Osage, and are formed from the gravel that is brought down by said stream. Every little mountain rill and every washout on the steep hill slopes furnishes its quota of gravel, which will always be a source of trouble and obstruction to the permanent navigation of this river.

The perpendicular rock bluffs along the shores are composed either of soft lime or sand stone, and in the process of disintegration large masses are thrown down, often finding a lodgment in the channel of the river, making it dangerous for any one to navigate this stream who does not know the exact location of these rocks, particularly so in the pools, where there is no ripple of the water to indicate their presence.

There are comparatively but few snags to be found in this section of the river, and these can easily be removed.

There are overhanging trees in many places, which should be cut down where the low-water channel runs close to the shore, as there is danger of contact with the upper works of steamboats, as was the case with the boat that transferred our party to Rainey Creek.

This section of the river can be divided into two divisions. From Rainey Creek to Linn Creek it can only be made navigable for boats drawing from 12 to 14 inches of water when the river is at its lowest stage. There are twenty-three shoals in this division.

One-quarter of a mile above Linn Creek is the mouth of the Niangua River, a stream of considerable size, which is fed by perennial springs, and from which the Osage derives nearly one-half of its supply during low-water. The other branches of creeks, with the exception of Big Gravois, afford but little water during the dry season, except from local rains. This division can, if the water is all concentrated in one channel, be made navigable for any boat that can pass over the bars below Tuscumbia. There are thirty-three shoals on this division. Above Linn Creek all the bars will need more or less improvement to give 1¼ feet of water in the channel at a low stage.

The following shoals on this division have been improved by the State of Missouri: Rainey Creek, Byers, McFarlin's, Rapids, Coffman's, Wilson's, Henry Cable's, Peter Cable's, Bollinger's Creek, Porter Mill, Foster Island, Cash Williams, Melbourne Williams, and Austin Cranes.

The following are the shoals that are impassable for boats drawing more than 14 inches of water: Rainey Creek, Byers, McFarlin's, Rapids, Henry Cable, Peter Cable, Bollinger Creek Nos. 1, 2, and 3, Porter Mill, Cash Williams, Melbourne Williams, and Austin Cranes. At the last-named place the channel has filled completely up with gravel. A break has been made in the left wing-dam, through which the water rushes with great force, impinging the left bank at such an angle as to make it impossible for any boat to pass with safety when the river is at a low stage. There is also a break in the right wing-dam. The filling of the channel was probably caused by the breaking of the dams and thereby lessening the velocity and scouring power of the water in the channel.

Below Linn Creek the following shoals have been improved by the State of Missouri: Linn Creek, Town, Friar Ear No. 1, Foley Island, Big Kinsile, Little Kinsile, Salt Island No. 1, Au Glaize, Rays No. 1, Wash. Lamb No. 1, Wide Ford, Round Island, Big Gravois No. 1, Lower Howser, Little Gravois No. 1, Granny's Island, Russell's Island, A. Brockman, and Tuscumbia.

The following shoals will need improvement to give a channel of 2 feet depth at low-water: Linn Creek, Town, Friar Ear Nos. 1 and 2, Foley Island, Big Kinsile, Salt Island No. 1, Au Glaize, Rays Nos. 1 and 2, Round Island, Widow Stephens, Big Gravois Nos. 1, 2, and 3, Stephen Howser, Easter's, Little Gravois Nos. 1 and 2, Granny's Island, Russell's Island, A. Brockman's, and Tuscumbia. At some of the above-named places the shoal extends but a short distance, and can be removed by scraping or dredging, and will not need the construction of permanent works.

I would respectfully call your attention to the location of the State dams and dikes. In some cases they are located just below the mouth of some creek, and in such a position as to catch and convey all the gravel that is brought down by said creek, directly into the low-water channel, thus defeating the very object for which they were designed and constructed.

I am under obligations to Assistant Engineer Mr. W. S. Simpson for valuable aid in fitting out party at Jefferson City, also for transportation of myself and party to Tuscumbia and afterwards to Rainey Creek. I acknowledge with pleasure the efficient manner with which my assistant, Mr. John O. Holman, has performed his duties in the field and valuable aid rendered in the preparation of the maps and profile in the office.

Very respectfully, your obedient servant,

S. E. McGregory,
Assistant Engineer.

Capt. O. H. Ernst,
Corps of Engineers, U. S. A.

R 6.

SURVEY OF FISH BEND, NEAR FORT CHARTRES, IN THE MISSISSIPPI RIVER.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., December 31, 1881.

GENERAL: I have the honor to transmit herewith a map of Fish Bend, near Fort Chartres, in the Mississippi River, surveyed in August and September last, to comply with the provisions of the river and harbor act of March 3, 1881.

Fish Bend is situated about 40 miles below Saint Louis. The river leaves the Missouri bluff near Rushtower Landing and makes an incursion into the alluvial bottom on the Illinois side, returning to the Missouri bluff again at Penitentiary Point. The channel, following the Missouri shore as far as Rush Island, crosses over to the Illinois shore below Goodman's Landing, and thence follows that shore nearly to Penitentiary Point. The deep concave bend which it has excavated for itself in the Illinois shore is known as Fish Bend.

The land on the Illinois side is almost entirely cleared of trees, and is under cultivation; the soil is the light, sandy alluvion of the Mississippi Valley, and the direction of approach of the river is favorable to attack. These circumstances are all conducive to rapid erosion.

The bend was surveyed under the direction of my predecessor in 1874, and again in 1879. The shore lines, as developed by those surveys, are indicated on the map. They show a marked advance into the Illinois bottom, with a general movement of the bend down stream. The greatest amount of excavation since 1874 is found just below Salt Lake, where the Illinois bank has receded about 1,875 feet, which is at the rate of 268 feet per year. The greatest excavation since 1879 is found just above Salt Lake and above Penitentiary Point. At the former place the bank has receded 794 feet, or 397 feet per year; and at the latter place 835 feet, or 417½ feet per year. Between these points there is one place where for a short distance the excavation has been almost nothing since 1879, though very large since 1874. The amount of land destroyed since 1874 is about 523.8 acres, or about 75 acres per year; and since 1879 about 180 acres, or 90 acres per year. Estimating the value of the land at $50 per acre, and taking the more recent rate of annual destruction, the annual loss is about $4,500.

The obvious means to prevent this loss is to strengthen the bank by a revetment. An efficient revetment includes a continuous mattress 120 feet wide laid at the foot of the slope below low-water mark, above which the bank is to be graded to a gentle slope and covered with a layer 1 foot thick of broken stone up to a height of 16 feet above low-water mark, and above that level to be planted with willows. The foot mattress should be made absolutely continuous if practicable, but if the current be too swift for progressive sinking, it should be made in sections not less than 1,000 feet long, and these should overlap each other so as to make the protection absolutely continuous when in place.

The cost of such a revetment is now estimated at about $10 per running foot, though it is possible that, as the men are trained and become more expert, the cost may be reduced. The total length of bank requiring protection from Goodman's Landing to Penitentiary Point is 19,166 feet. The total cost of protecting Fish Bend would be $191,660.

The annual interest upon this sum at 4 per cent. is $7,666.40, while the present annual loss from the destruction of land is but $4,500.

In stating the amount of commerce to be benefited by such an improvement some explanations are necessary. The result of rapid caving of a bank is not only to inflict loss upon the riparian proprietor, but it is also injurious to navigation, by throwing into the stream a larger amount of material than it can carry. This material is at first swept along by the swift current usually prevailing in a sharp bend, until it reaches a crossing or wide place below, where it is deposited, and where it forms a shoal. In general terms, the protection of any bank from erosion is beneficial to navigation by shutting off that supply of channel-choking material. But to stop the caving in a single detached bend may or may not be of permanent value to navigation. In a river having alluvial banks one bend is supplemented by other bends on the opposite side, above and below. The material excavated from one bend is often dropped upon or below the adjacent point, causing accretions, and the result is that the location of the bend is steadily moving down stream, the upper portion being filled up as this movement progresses. If, in such a case, a detached bend be protected, and the opposite bend above be left unprotected, the works placed in the former will, in time, be buried, and will have served only a temporary purpose, the river seeking a new location for itself somewhere else. It sometimes happens, also, that the river will desert a well-defined bend, cutting a new channel for itself across the opposite point. It may be laid down as a rule that no permanent benefit to navigation can be expected with confidence from the protection of a single detached bend. To insure permanent benefit the direction of approach of the channel must be fixed, and this involves the systematic improvement of the river above. While the protection of Fish Bend at this time would, without doubt, be of benefit to navigation for the time being, the work should not be undertaken in the interest of navigation until it shall be known with certainty where the bank of the river in this vicinity is to be in the future. The general improvement of the river now progressing down stream from Saint Louis will reach a point about 15 miles above Fish Bend during the coming year. Its rate of advance being dependent upon the amount of future appropriations, it is uncertain when this locality will be reached.

It is therefore concluded that the protection of Fish Bend at this time will be a work for the protection of land, and that the benefit to commerce to be derived from it will be insignificant.

Very respectfully, your obedient servant,

O. H. Ernst,
Captain of Engineers.

Brig. Gen. H. G. Wright,
Chief of Engineers, U. S. A.

APPENDIX S.

REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI AND MISSOURI RIVERS—SURVEYS AND IMPROVEMENTS AT VARIOUS POINTS ON MISSOURI RIVER—SURVEY OF MISSOURI RIVER FROM ITS MOUTH TO SIOUX CITY.

REPORT OF MAJOR CHARLES R. SUTER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. **Removing snags and wrecks from the Mississippi and Missouri rivers.**
2. **Missouri River at Saint Charles, Mo.**
3. **Missouri River at Cedar City, Mo.**
4. **Missouri River at Glasgow, Mo.**
5. **Missouri River at Lexington, Mo.**
6. **Missouri River at Kansas City, Mo.**
7. **Missouri River at Fort Leavenworth, Kans.**
8. **Missouri River at Atchison, Kans.**
9. **Missouri River at and near Saint Joseph, Mo.**
10. **Missouri River at Brownville, Nebr.**
11. **Missouri River at Eastport, Iowa, and Nebraska City, Nebr.**
12. **Missouri River at Plattsmouth, Nebr.**
13. **Missouri River at Council Bluff, Iowa, and at Omaha, Nebr.**
14. **Missouri River at Sioux City, Iowa.**
15. **Missouri River at Vermillion, Dak.**
16. **Missouri River between Kansas City and its mouth.**
17. **Missouri River from its mouth to Fort Benton, Mont.**
18. **Gasconade River, Missouri.**
19. **Missouri River from its mouth to Sioux City, Iowa, &c.**

EXAMINATIONS AND SURVEYS.

20. **Missouri River at or near Arrow Rock.**
21. **Nishnabotana from Hamburg, Iowa, to its junction with the Missouri.**

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., September 30, 1882.

GENERAL: I beg leave to submit herewith my annual report upon the operations committed to my charge during the fiscal year ending June 30, 1881.

I am, general, very respectfully, your obedient servant,

CHAS. R. SUTER,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

NOTE.—The maps, diagrams, &c., referred to in this appendix were received at the office of the Chief of Engineers too late to be printed.

S 1.

REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI AND MISSOURI RIVERS.

Work on that portion of this improvement which was under my charge was carried on by the three large snag-boats—J. N. Macomb, H. G. Wright, and R. E. De Russy. They commenced operations at the beginning of the fiscal year, and work was continued throughout the season as needed. The long-continued high water in the latter half of the year greatly interfered with the work. Only ten months' work could be done on the Mississippi, the operations extending over 860 miles of river. The snagging on the Missouri was done under another appropriation, and the work on the Arkansas was not under my direction.

MISSISSIPPI RIVER.

Work on this stream extended from the mouth of the Missouri to Vicksburg, 860 miles. All three boats were employed on it, and their aggregate period of service was ten months.

The snag-boat Macomb left Mound City, Ill., July 1, 1881, and worked from Cairo to Saint Louis. She turned back from this point July 14, and worked down to Vicksburg, Miss., arriving there August 11. Thence she worked back to Cairo and lay there repairing from September 12 to 28. She then resumed operations and worked down to Vicksburg again, reaching there October 17. From this point she worked back to Cairo and was laid up at Mound City, Ill., November 30, the great flood in the Mississippi rendering any further operations impossible. She was in commission five months, and worked four times over the river from Cairo to Vicksburg, and twice from Cairo to Saint Louis.

The snag-boat De Russy left Mound City, Ill., August 20, 1881, and was kept at work between Saint Louis and Cairo till November 16, when high-water obliged me to lay her up. She resumed work in the same field February 1, 1882, but another flood put a final stop to her operations February 24, when she was laid up at Saint Louis. She was in commission four months and worked five times over the river from Cairo to Saint Louis, her work giving great satisfaction. The snag-boat Wright was temporarily detailed for work in the Mississippi near Saint Louis in August and again in March, the pressure of work there being too great for one boat. Her operations in the Mississippi aggregated one month in time.

Table of work done in Mississippi River.

Name of boat.	Number of snags pulled.	Weight in tons of 2,000 pounds.	Number of trees cut.	Number of drift piles removed.	Number of miles run.
J. N. Macomb	1,130	19,839 5	1,878	19	3,024
R. E. De Russy	589	15,177 8	3,567	12	1,347
H. G. Wright	190	1,581 2	38	1	603
Total	1,909	36,598 5	4,383	32	4,974

Estimate.

For repairing one wooden snag-boat and fitting it up for wrecking purposes	$50,000
For working expenses of three boats, ten months each, at $4,000 per month	120,000
Total	170,000

Money statement.

July 1, 1881, amount available	$.
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	75,
July 1, 1882, amount available	3,81.
Amount appropriated by act passed August 2, 1882	85,000
Amount available for fiscal year ending June 30, 1883	88,812 18
Amount that can be profitably expended in fiscal year ending June 30, 1884	170,000 00

MISSOURI RIVER.

Owing to the peculiar wording of the law, it was decided that none of the available boats could be used in working under the appropriation for this stream, and the snagging done there was paid for from the appropriation for improving Missouri River, from Kansas City to its mouth, and will be described under that head.

Estimate.

For building light-draught snag-boat	$80,000
For operating three boats, nine months each, at $4,000 per month	108,000
Total	188,000

Money statement.

July 1, 1881, amount available	$80,000
July 1, 1882, amount available	80,000
Amount appropriated by act passed August 2, 1882	65,000
Amount available for fiscal year ending June 30, 1883	145,000
Amount that can be profitably expended in fiscal year ending June 30, 1884	188,000

CONSTRUCTION OF NEW BOATS.

The whole amount appropriated for snagging on the Missouri River was reserved for the construction of a boat for special service on that stream, but the amount being insufficient for the purpose nothing more was done than to prepare plans and working drawings. As funds from the new appropriation are now available, the construction of the boat will soon be commenced and pushed to completion as soon as possible.

I am very desirous of building a stern-wheel snag-boat for service on the Upper Missouri, and an estimate of $80,000, therefore, is submitted and recommended, as well as an estimate of $50,000 for repairing the wooden snag-boat De Russy, which cannot be kept afloat much longer. When this work is done it is my intention to set her at wrecking work, of which a vast amount is required.

OPERATIONS FOR THE COMING SEASON.

The plans submitted to you contemplate the construction of the Missouri River snag-boat, current repairs to the fleet, and the performance of twenty-seven months' snag-boat work, of which nineteen will go to the Mississippi and eight to the Missouri.

The work is situated in the collection district of New Orleans.

The amount of revenue collected at the port of Saint Louis, Mo., during the fiscal year ending June 30, 1882, was $1,676,951.56.

The commerce benefited by the work is that of the entire Mississippi Valley.

S 2.

IMPROVEMENT OF MISSOURI RIVER AT SAINT CHARLES, MISSOURI.

At the date of my last annual report the works of channel contraction at Downing's Point and at the head of Saint Charles Island, as well as the works designed to close the chute behind this island, were well under way. Their construction was continued, and substantial results had been obtained, when in November a violent and wholly unexpected rise in the river caused such damage to the incomplete works that the effects produced by them have not been as great as had been anticipated. Still the effect was marked, and in the right direction. Owing to lack of funds the contemplated revetment in Saint Charles Bend had to be deferred. It will be constructed this year with funds allotted from the general appropriation for improving Missouri River from its mouth to Sioux City, Iowa. After this work, which is mainly conservative in character, is completed, it is thought that further work in this neighborhood had best be deferred till it can be undertaken with ample funds in the course of execution of the general project for improvement.

The work has been in charge of Assistant L. E. Cooley, to March 1, 1882, and of Assistant F. M. Harris from that date.

This work is situated in the collection district of New Orleans, and the nearest port of delivery is Saint Louis, Mo. The nearest fort is at Leavenworth, Kans.

Amount of revenue collected at the port of Saint Louis, Mo., during the fiscal year ending June 30, 1882, was $1,676,951.56.

Money statement.

July 1, 1881, amount available	$15,881 31
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	15,384 46
July 1, 1882, amount available	496 85

REPORT OF MR. F. M. HARRIS, ASSISTANT ENGINEER.

SAINT CHARLES, MO., *June* 30, 1882.

MAJOR: I have the honor of submitting the following report of operations conducted at Saint Charles, Mo., during the year ending June 30, 1882:

Assistant L. E. Cooley, who had charge of the season's work at this place, was transferred to the general office at Saint Louis, March 31, 1882. In his annual report for 1881 the work then in progress was fully outlined. Since that date the work indicated has been completed so far as the funds available would permit. The greater part of the force employed on construction was discharged July 31, 1881. A small party was kept on construction and on physical and survey work until the middle of November, since which time operations have been limited to office work on maps, physical data, and designs for plant.

No revetment has been laid during the year. Construction has been confined to training works, in the hope of securing a course for the river that would require a less extent of permanent works.

In furtherance of this plan, continuous wire netting, anchored with bailed rock, and supported by piles, tripods, or buoys, as demanded by the exigencies of the case, has been used. Of this construction there has been placed 8,500 feet, or a little more than 1.6 miles, about two-thirds of which were embraced in the system located at Downing's Point, and the balance at the head of Saint Charles Slough. In all, thirty tripod-frames and seven hundred box-buoys have been constructed and used, one thousand piles have been sunk, and 500,000 square feet of wire netting have been woven and laid.

In discussing the merits of these constructions, tripod-frames and buoys are regarded as expedients, useful in making repairs, and in miscellaneous work.

APPENDIX S.

PILE-SINKING.

Cottonwood piling was used averaging 36 feet in length and 12 inches in at the butt. In main-line work these were sunk in A bents, lashed with wire, a bolted with three-fourths inch square iron. The bents were spaced from 25 to apart. Every 200 feet a third pile was added to the A bent, forming a tripod. over all, a seven-eighths inch wire rope was secured. In auxiliary lines the were sunk vertically, spaced 16 feet apart, and connected with one-half inch w rope. The depth of water ranged from 10 to 22 feet.

The water-jet has been used for pile-sinking. The penetration attained varied from 10 to 18 feet, according to formation encountered and time consumed.

The arrangement of machinery and boats is shown in the accompanying sketches, numbered 1 to 3.

DESCRIPTION OF PILE-BOAT.

An L-shaped boat was made by bolting together two ordinary barges. The main barge carried a boiler, pump, winch, and derrick. The cross barge carried a platform 9 feet above the deck. From this platform and the deck below finger-guides projected.

The method of working was as follows: The boat was placed on the upper side of the proposed dike, with cross barge down stream. The piles were prepared, dogged separately at the butt, and made fast to the down-stream gunwale. A pile was then drawn in on the working gunwale, butt up stream, and the pipe placed in position. Then the derrick line was attached near the top of the pile. When this end was sufficiently elevated, a heel rope was passed around the butt, the pile launched, lowered away, and allowed to settle back into the finger-guides. The upper finger and the heel rope were removed as soon as the pile touched bottom. The friction and buoyancy was overcome by a warping-line led to the winch.

The above method was an outgrowth of one designed and constructed on this work last year, similar in all its main features to the one recently designed and constructed by Assistant Pease, at Council Bluffs.

The manipulation of the adjustable finger-guide from the deck was not considered satisfactory, and the fixed platform was substituted.

The machinery used was as follows:

Boiler (vertical), 10 P.

Pump (Worthington duplex pressure), 10–5¼ by 10 inches.

Hose, 50 feet long and 2 inches in diameter.

Gas-pipe, 36 feet long and 1¼ inches in diameter.

Water-jet, 1 inch in diameter.

Quantity of water per minute, 16 cubic feet.

Water-pressure at nozzle, 51 pounds.

COST OF LABOR.

The cost per foot of support was as follows:

1 foreman, at $4 per day of ten hours	$4 00
1 engineer, at $2.50 per day of ten hours	2 50
5 laborers, at $2 per day of ten hours (sinking drift-bolting piles, securing wire rope, and shifting boats)	10 00
2 laborers, at $1.50 per day of ten hours (preparing piles)	3 00
2 laborers, at $1.50 per day of ten hours (delivering piles)	3 00
Total per day (of ten hours)	22 50

Average speed per day, thirty-five piles or 500 feet of dike.

Cost of labor per foot of support, 4½ cents.

The season's experience with the above method has been most encouraging, and promises results far in advance of any yet attained. For the best results, however, the pump and boiler capacity should be doubled. It has been found necessary, in securing proper penetration, to keep the material alive in close proximity to the pile, which has been accomplished by jarring with mauls and by swaying. A mechanical agitator should be substituted. The head-line strain could then be continuous, but in no case should it be excessive.

The axial application of the jet is believed to be indispensable to good work. The method of securing this and a prompt withdrawal of the pipe admits of many modifications. Eight forms have been tested this season, and that giving best results is shown in accompanying sketch, No. 4.

The labor of preparing the pile should be reduced to a minimum, and a groove and block would undoubtedly answer every purpose.

Extreme simplicity must be observed in an efficient design. Special attention should be given to the details involved in the rapid handling of the boat and in securing proper alignment, in securing speed in handling the pile and withdrawing the pipe, in the means of agitating the material adjacent to the pile, and to the capacity of pump and boiler.

WIRE NET.

The net-machine, in course of development at the date of last report, was used throughout the season. The skeleton-drum, carrying hoops with studs or notched flanges, was made in sections, and the requisite number bolted together and mounted on an L-barge, as shown in sketch No. 6. The wire is used directly from the coil. The looping may be done with one or any number of wires. The pin-twist is used as a fastening, two turns being sufficient. Any form of mesh may be made by shifting the rings and looping for the mesh required.

A square mesh, area one square foot, was used for main-line work. The diamond and triangular mesh possess the merit of freeing themselves more readily from the studs after the twist is made. This advantage is somewhat annulled in the triangular by the necessary side wires.

COST OF LABOR.

The itemized cost of labor in making and placing net is as follows:

1 foreman, at $2 per day of ten hours	$2 00
5 loopers, at $1.50 per day of ten hours	7 50
5 twisters, at $1.25 per day of ten hours	6 25
1 laborer, at $1.25 per day of ten hours (securing air edge)	1 25
1 laborer, at $1.50 per day of ten hours (attaching rock)	1 50
2 laborers, at $1.25 per day of ten hours (boating rock)	2 50
Total per day of gang	21 00

Size of mesh, 1 square foot.

Width of net, 60 feet.

Maximum speed per day of ten hours, 500 feet.

Average speed per day of ten hours, 375 feet.

Cost of labor per square for making and placing net (375 linear feet), 9⅓ cents.

Cost of labor per linear foot for making and placing net (average speed), 5.6 cents.

Most of the net was placed as made; but a considerable quantity of stock net of various widths was made during odd hours and used as occasion required. In observations made to determine the proper size of mesh to produce maximum fill in a given time, it has been found that the accumulation of fiber ceases at a certain point, dependent on the velocity. In a 4-mile current the strands reached a diameter of about 3 inches, presenting, on a 12-inch mesh, a cross-section of nearly one-half.

In the Downing-Point system this produced a fill varying from 3 to 20 feet in depth, over an area of nearly 1 square mile, during the months of July and August.

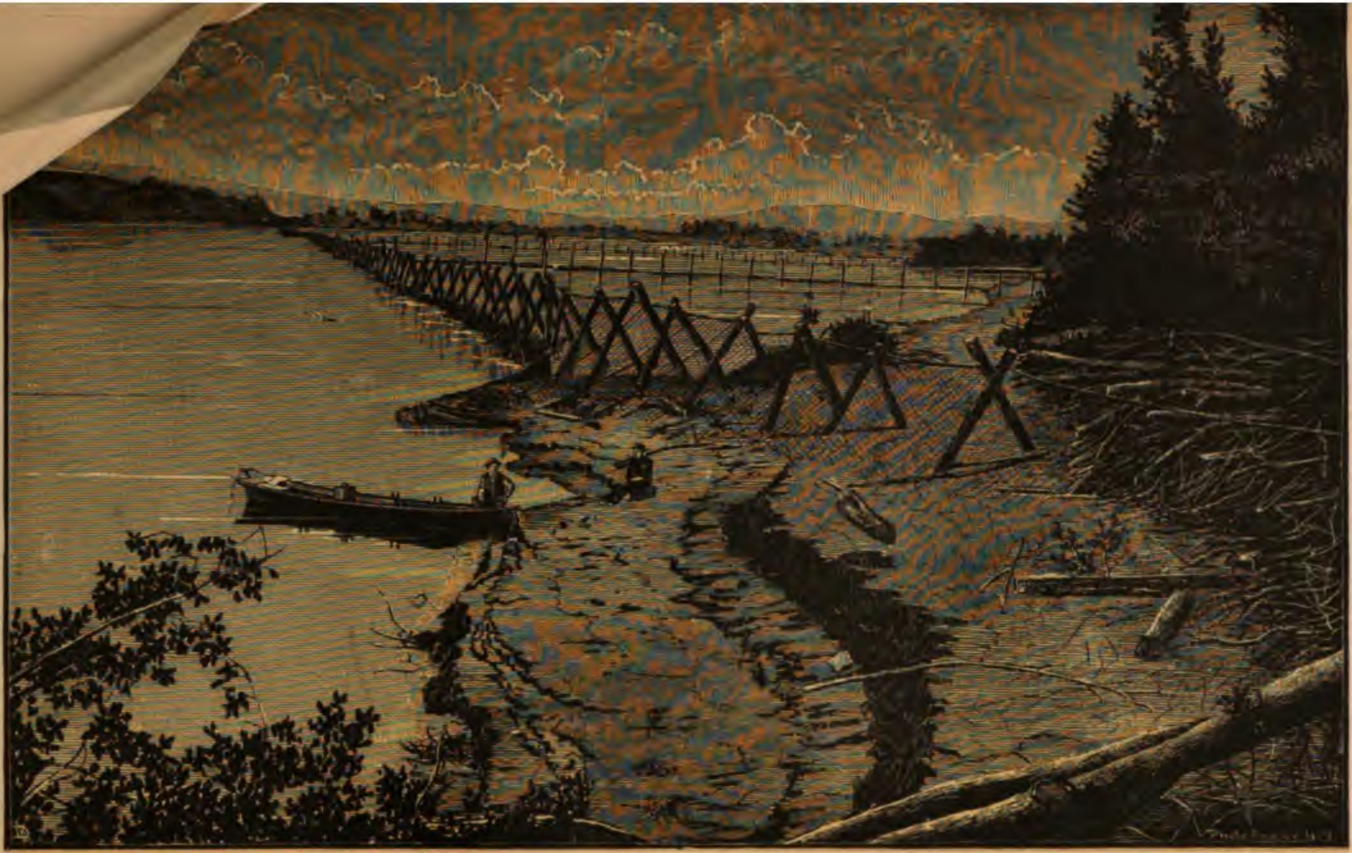
It is not regarded impossible for a less cross-section under like conditions to produce results equally good. A more thorough and complete investigation of this subject would certainly be in the interest of economy.

COST PER LINEAR FOOT OF TRAINING WORKS.

		Cents.
Labor		10$\frac{1}{10}$
Material:	piles	15
	wire rope	12¼
	bailed rock	2⅙
	drift-bolts	⅚
	lashings	⅙
	net-wire	14⅜
	coal	¼
Total		56

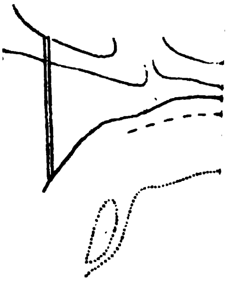
Training works may be considered fairly beyond the experimental stage and within the range of estimate. Aside from minor details, the only remaining question to be disposed of is their protection from ice and drift-wood.

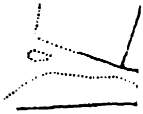
The latter is most formidable in this portion of the valley, and all efforts to utilize it for protection or for silting purposes have failed. It is at present regarded only as a disturbing element. For exposed dikes there appear to be but two solutions, viz, a construction strong enough to withstand these accumulations, and a submerged dike possessing the merits of the buoy-dike without its defects. Considering the vast



SCREEN-DIKES AT DOWNING'S POINT, MISSOURI RIVER IMPROVEMENT, SAINT CHARLES, MO.

[Main dyke, 3,600 feet; cross-dikes, 2,000 feet. July, 1881.]





quantity of drift-wood brought down by the frequent and sudden rises in this part of the valley, the submerged dike would seem to possess superior advantages. But either solution reduces to a question of expense. When supported on piles the netting is not re-enforced by the bar, as in the case of buoyed net, as illustrated in the following sketches:

This objectionable feature is due largely to the presence of drift on the face of the dike. A protective line of piling driven at "C" would remove the drift to a less destructive point, and strengthen the main line. The same purpose might be more economically served by chord-timbers of suitable length attached, one end to the waling, the other to the anchor-edge of the net. These placed at regular intervals would also aid in securing proper alignment for the net, a point requiring special attention, as any local tendency in the netting to bag against or between the piles is rapidly augmented by the floating débris until a draw is inaugurated and the piling and net are subjected to severe scouring and chafing. The damage to the Downing's Point Dike caused by drift and change of channel above was made the subject of a special report December 6, 1881. The damage to date consists of a reduced bar-height on the point opposite the head of Saint Charles Slough.

The shore line proposed for the left bank immediately above the head of Saint Charles Slough was obtained in January, and in connection with the training works at this point threw the crossing away from the head of Saint Charles Island 3,000 feet, or about one-half of the proposed distance. The revetment contemplated for this bank could not be placed with the funds then available, and much vantage ground has been lost. The bend opposite the city of Saint Charles must soon respond to the new course of the river if that course can be maintained. The water now enters this bend in a direction favorable to the establishment of works in the vicinity of the Saint Charles Rock road. It is thought that training works connected to the rock exposure above with substantial mattress work can now be projected from this portion of the bend, and will accomplish the results demanded by local interests in this part of the reach.

MATTRESS WORK.

Although no regular mattress work has been undertaken this season, yet considerable experimental study has been given the subject. Sections of net closely filled with brush were laid at the head of the lower training works, but with rather discouraging results. Attention was then given to an all-wire mattress, with a view of utilizing the fiber as in the net. Several methods of weaving a wire net for this purpose have been devised. The design best developed weaves a continuous spiral web, and consists simply of a series of rollers which thrust the wires through short spiral tubes. By changing the tubes the machine may be used for making net. Sections of this web have been tested with an inch jet, and appear to have some merit as a bank protection. With some attention given to the preservation of the wire, such a construction may become of more than secondary importance.

PHYSICAL INVESTIGATION.

The urgent need of physical investigations in this portion of the valley, and the serious mistakes liable to occur unless they be extended, have been set forth in special reports. A hand-probe of inch gas-pipe has been used during the season to investigate proposed shore lines and channel ways, and has become a valuable adjunct to our plant, but is not adapted to a depth below 50 or 60 feet.

A cross-section of the valley, starting from △ 9 at the southern limit of the city, has been made with this apparatus.

The clay layers, ranging from 1 to 3 feet in thickness, noticeable in vertical banks at low water, are apparently continuous over large areas. While this formation, sandwiched with lighter material, affords little protection when cut through, yet it must determine in some degree the limit of scour, and may account for the excessive wanderings of the chutes and draws into this reach.

The fact that one-half of the valley on this section has been worked over by the river since 1868 would indicate that this stratification continues at the present time and is supplied from cutting banks. The stratum located at an elevation of 40 feet could not be penetrated with the apparatus at hand. Information gathered from the cross-section and a parallel one at the head of Saint Charles Slough, not yet completed, would identify this with the bowlder-bearing stratum met in the foundations of the Saint Charles Bridge.

Very respectfully, your obedient servant,

F. M. HARRIS,
Assistant Engineer.

Maj. CHAS. R. SUTER,
Corps of Engineers, U. S. A.

S 3.

IMPROVEMENT OF MISSOURI RIVER AT CEDAR CITY, MISSOURI.

The work in progress at date of last report, viz, the construction of a wire-screen dike across the large bend in front of Cedar City, was continued during the season, and completed. The work has been eminently successful, and the bend has been entirely silted up, while all the water flows in concentrated volume past Jefferson and Cedar cities. Some slight work was also done in Murray's Bend, above Cedar City, but as nothing more is locally needed at present, it has been decided to defer further work till this point is reached in the general improvement of the river.

The work has been in charge of Assistant T. C. Bradley.

The work is situated in the collection district of New Orleans, and the nearest port of delivery is Saint Louis, Mo. The nearest fort is at Leavenworth, Kans.

The amount of revenue collected at the port of Saint Louis, Mo., during the fiscal year ending June 30, 1882, was $1,676,951.56.

Money statement.

July 1, 1881, amount available	$16,837 19
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	16,526 99
July 1, 1882, amount available	310 20

REPORT OF MR. T. C. BRADLEY, ASSISTANT ENGINEER.

CEDAR CITY, MO., *July* 5, 1882.

MAJOR: I have the honor to submit herewith the following annual report of operations at Cedar City for the fiscal year ending June 30, 1882:

The work at this point has been carried on under approved project of March 21, 1881, and completed so far as the funds would allow.

The Cedar City Dike and the revetment placed to protect the city front were partially completed at the time of writing the last annual report under date of July 13, 1881. The history of the various attempts at river improvement in the vicinity, together with a description of the methods and appliances employed, is given therein a length.

The appropriations have been so small that no attempt has been made to get u special plant for any of the work. In consequence no figures on the cost of the wor in detail can be given that will have any value by way of comparison with those o other works. After it was determined that the funds available for field operation would not allow the building of labor-saving appliances to expedite and facilitate th work, the problem has been to devise expedient methods.

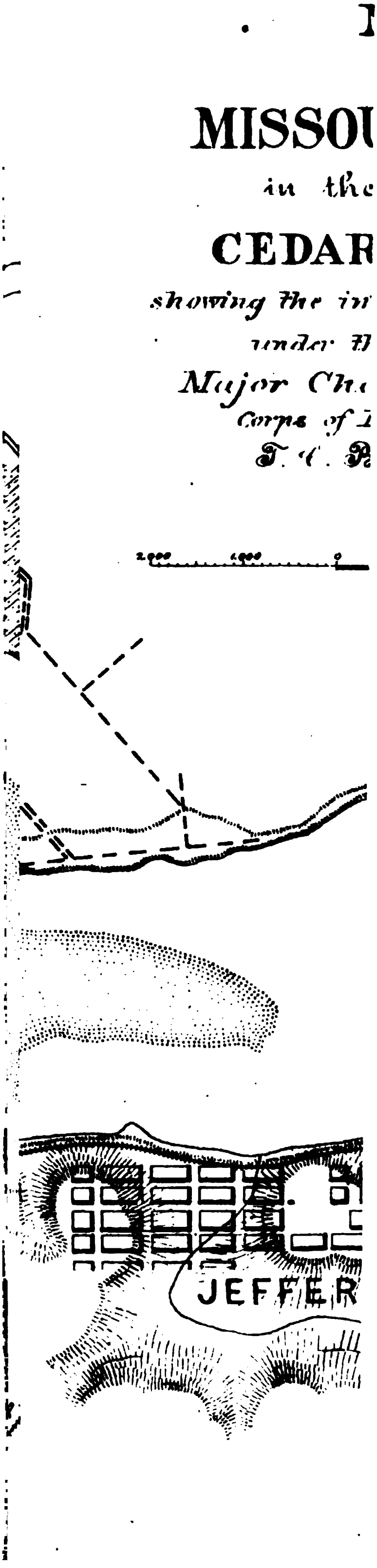
The methods used in the manufacture of netting and the placing of the work, it i believed, were more primitive than at any other point on the Missouri. The cost work is correspondingly great.

CEDAR CITY DIKE.

This work is considered the most important that has been undertaken here, and wa projected to save Cedar City and the valuable lands above by cutting off the left chu and forcing the channel down the right bank past Jefferson City. The tree dik placed by the citizens, and the Brownlow Weed dike, placed under your directio failing to change the course of the channel at this point, a wire-screen dike was pr jected to accomplish the desired result.

It was first contemplated to place 1,000 feet of cross-dike at the head of the chu leading out into the river and to connect it with 3,000 feet of trailing dike runnin down stream and parallel to the right bank, the channel being thus contracted 1,300 feet in width.

The trailing dike was afterwards increased in length 1,000 feet to connect mo closely with the long bar that divided the channel nearly equally. This bar lies o posite Jefferson City. The total length of dike placed was 5,000 feet.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In order to take advantage of the early rise, work was commenced on the cross-dike April 13. The tripod support was used and was placed in position by the aid of a boom-derrick placed on a barge.

This system is only efficient in shallow water. Where the water is over 17 feet in depth the tripod support will not be found an economical device. After the failure of tripods, from overturning, the buoyed curtain was tried, but not successfully.

The curtains were placed in sections, shingling down stream. The difficulty of placing and the uncertainty of their remaining, owing to failure of buoys and dragging of anchors, prompted the abandonment of this method.

The last resort was piling, driven in pairs by the jet.

The lower 2,500 feet of dike was supported by double piles, 20 feet apart and connected by a wire rope three-quarter inches in diameter. A Worthington duplex pump, 10 by 6 by 10 inches, was placed on the steamer and was used in sinking all the piles.

Cottonwood piles from 35 to 45 feet in length and 14 inches in diameter at the butt were used. They were prepared by cutting a notch near the large end and boring a hole up through the center in such a manner as to admit a 2 inch gas-pipe, delivering an inch jet at the center of the pile. The pile being placed in position for sinking, a downward strain was applied, and the pump set at work.

This downward strain was found necessary, and may be best applied by the use of steam-power. Any jarring motion will be found to aid the pile in sinking.

The piles were sunk at an angle, the pair resembling the letter A, making an angle between 15° and 20°. They were secured by drift-bolting and wrapping with wire.

The mesh of the netting giving the best results was rectangular in form, 2 feet on the horizontal by 1 on the vertical. No. 12 steel-annealed wire was used, pin-twisted at the intersections.

The netting was given a width not less than twice the depth of the water, and sunk by attaching bailed rock to the lower edge. The netting was launched from a barge and the anchors guided to the bottom by means of a trailing-boom.

The effect of the dike was marked very soon after placing; the wires, catching rootlets, grass, and débris increasing in size from one-half to one inch in diameter. This increased resistance, opposed to the current, reduced the velocity, and a deposit of sediment was the result.

The cross-sections show deposits after each rise, and the entire bend has given place to dry bar at average stage of water.

The dike has accomplished more than was expected of it. Its success may be attributed to the fact that the year was most favorable for dike-work, and the work was placed very early in the season.

The question of the efficiency of the screen-dike as a means of channel rectification I think is settled. The results obtained on this work demonstrate that the direction of the current can be changed and shore lines built up.

Ice and drift are found to be the most serious enemies of the dike. To eliminate or reduce these disturbing elements to a minimum is still a problem. For piling, the safest precaution is to keep the air-edge below the high-stage line, especially in channel work. The drift will then pass over. So far as ice is concerned, it is thought very little trouble will be experienced. In most cases the desired results will be obtained before ice could damage the dike-work. In this case its destruction would not signify.

Generally dike-work will be considered temporary rather than permanent work, and its life need not exceed one season.

CEDAR CITY REVETMENT.

As indicated in the last annual report, 1,000 feet of revetment was placed above the old bridge abutment, extending up to the mouth of Cedar Creek. This work was found necessary as a key to the work previously placed between the abutment and the Cedar City point.

Caving action had set in consequence of the screen-dike. Under its influence the channel moved down stream, gradually leaving the bend. When the current moved down far enough to strike between the mouth of Cedar Creek and the old bridge abutment, caving action became a serious matter, as the whole system of sectional mats along the city front was endangered.

To prevent the river from getting in behind, a continuous mattress, 75 feet in width, consisting of willows, was projected. The willows were laid at right angles to the bank and secured between two nets, with meshes 4 feet square, forming a mat about 4 inches in thickness.

The bank was not graded and no high water protection was laid, as the mattress was only designed as a temporary work to maintain the old work until the dike could act.

MURRAY BEND REVETMENT.

This revetment was designed to protect the left bank from erosion between stations 24 and 17, on what is called the Murray Bend Crossing. The direction of this crossing is very nearly at right angles to the bluff lines, and it has been moving down the valley for several years. In time all the works in the vicinity of Cedar City will give way unless it is made permanent.

The importance of holding this crossing was recognized, and a start made October 17 to lay a continuous mattress, beginning at station 24. It was a woven mattress of willows, having a width of 90 feet. The wire netting that served as a basis of strength was made on the launch-barge, of No. 12 and 14 annealed-steel wire. The mesh was rectangular in form, 2½ by 3 feet. The longitudinal wires, or those running lengthwise with the mat, were 5 feet apart.

The willows were woven into the netting as follows: The willow barge or feeder being placed at the outer end of the mattress barge, the willows were carried on the ways to the weavers, who were distributed along the edge of the ways. The willows were thrust down through the meshes of the net from 18 inches to 3 feet and then dropped back on the ways, making with them an angle of 45°. When this layer was placed a shift was made by dropping the boat down stream 5 feet. Another layer of willows was laid as before, the direction of the willows lying at right angles to the first. In this manner the weaving was carried on, making a rigid mat, the willows having a bond independent of the netting. To give additional strength to the mat, and prevent elongation at the expense of width, a fascine-boom made of willows was put in every 200 feet. This was made a part of the mat, and served as a good attachment for the bailed rock used in sinking It was given a diameter of 8 inches and a length equal to the width of the mat. The mat was given a thickness from 4 to 6 inches.

When the work began the Hydraulic Grader was still in use at Glasgow, and the mattress was placed without any grading. It was proposed to grade the bank after the mattress was finished. The only grading was topping off the bank just ahead of the work on a slope of 1 on 1. The small Worthington pump used in pile-sinking was placed on the steamer, and 2,600 feet of bank was thus graded. The work continued until December 6, when running ice and unfavorable weather forced a suspension of operations.

A tracing showing the location of work, and a photograph showing its effect, accompany this report.

In closing, I desire to acknowledge the services rendered by Mr. George W. Gender, my assistant, and J. K. Wilson and others who have been associated with me on this work.

Very respectfully, your obedient servant,

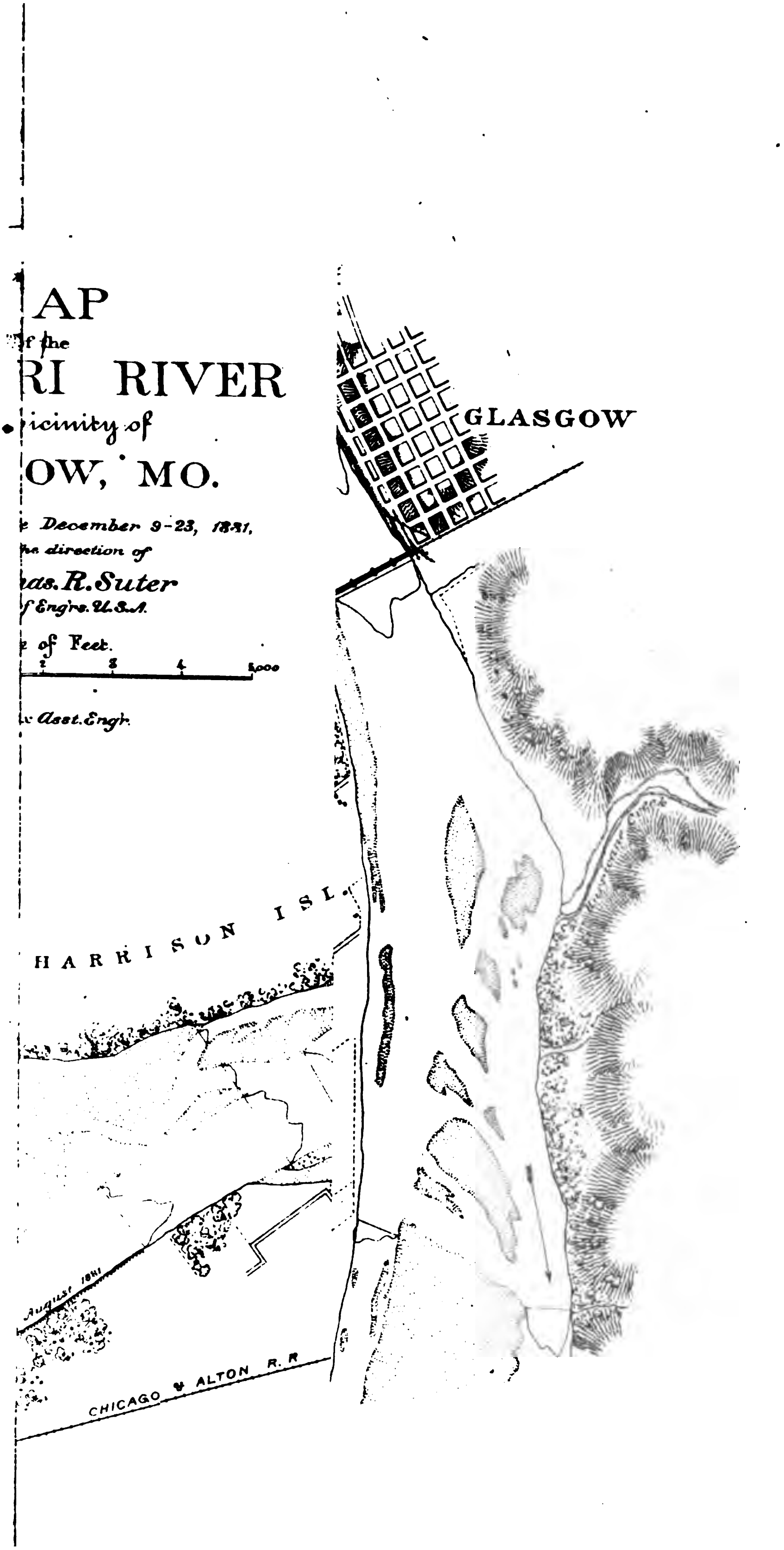
T. C. BRADLEY,
Assistant Engineer.

Maj. CHARLES R. SUTER,
Corps of Engineers, U. S. A.

S 4.

IMPROVEMENT OF MISSOURI RIVER AT GLASGOW, MISSOURI.

During the season of 1880 the Lower Bend, *i. e.*, the one immediately above Glasgow, was carefully revetted. This work proved perfectly successful, and no further danger being apprehended at that point, work during the past season was transferred to Cambridge and Middle Bends, farther up stream. Owing to lack of funds only very light mattresses could be used here, and the upper bank, although graded, was not protected. The work proved inadequate, and received so much damage that its renewal has become necessary. This work will be done during the present season by allotment from the general appropriation for improving Missouri River from its mouth to Sioux City, Iowa. After these con-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servative works are completed nothing more will be required beyond the general work of channel rectification, which it is thought can best be deferred till this point is reached in the course of the general improvement of the river. The work has been in charge of Assistant S. Waters Fox.

The work is situated in the collection district of New Orleans, and the nearest port of delivery is Saint Louis, Mo. The nearest fort is at Leavenworth, Kans. Amount of revenue collected at Saint Louis, Mo., during fiscal year ending June 30, 1882, was $1,676,951.56.

Money statement.

July 1, 1881, amount available	$15,263 43
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	15,058 51
July 1, 1882, amount available	204 92

REPORT OF MR. S. WATERS FOX, ASSISTANT ENGINEER.

SAINT LOUIS, MO., *July* 1, 1882.

MAJOR: I have the honor to submit herewith a report of the operations under my charge at and near Glasgow, Mo., during the fiscal year ending June 30, 1882.

The following illustrations are submitted, viz:

Map of Missouri River from Brunswick to Arrow Rock. Scale, 2,000 feet = 1 inch.

Three autotype views, showing construction of revetment in Middle Bend.

REVETMENT A, B.

Cambridge Bend.—In my report for the fiscal year ending June 30, 1881, dated July 14, 1881, the method of construction of this revetment as practiced up to July 1 was described. As stated therein it was not regarded as satisfactory. July 5 the following changes were adopted and maintained until the completion of the work. The trailing-boom, which had served to guide the outer edge of the mat to place, was abandoned because of the drift.

It then became necessary to provide some means for preserving the width of the mat while sinking it, the shrinkage being about 50 per cent.

This was accomplished very nearly by a rearrangement of the material, viz: The brush was laid on the netting across the ways or normal to the bank line. Over all, continuous wires, 10 feet apart, were passed up the ways, and pin-twisted to the netting at intervals of 2 feet.

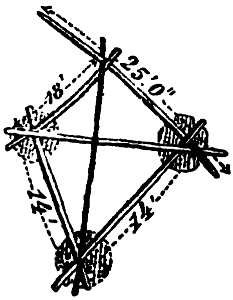
At best, however, the method was tedious, and the pin-twists bunched the brush either side of them, leaving large open places. To prevent the rock from falling through there, it was rolled up in willow curtains, the rolls being about 16 inches in diameter and 20 feet long. Six or eight sticks 3 feet long were run through each roll, serving both to confine the rock, and by taking hold on the mat to prevent rolling or sliding. They cost 48 cents each. In this way about 8¼ cubic yards of rock were required to sink 100 feet linear of mattress.

The total length of revetment was 1,200 feet. The average day's work of ten hours was 165 feet; the maximum, 204 feet.

TRIPOD DIKE B, C.

Cambridge Bend.—This work, begun July 15, was in accordance with the general project, and designed to establish a crossing to Cambridge.

Eighteen tripods of the form and dimensions shown in the sketch were placed in line, 25 feet apart from apex to apex.



Without breaking the continuity of the revetment netting, the width was reduced to 45 feet, and the meshes to 5 feet by 1 foot triangular.

The ground edge was anchored with bailed rock, the air edge being made fast to the wailing piece connecting the tripods. The dike was completed July 19.

The condition of the river, which governed its design, did not hold long enough to indicate fairly its capabilities. By a change above the current was delivered at the dike in a direction almost normal to its line. Under this continued action the tripods were scoured down until the entire dike had disappeared. Some of them remained upright; others overturned; the netting, though apparently intact, lies on the bottom.

REVETMENT.

Middle Bend.—The revetment of this bend was not contemplated in the general project, but was necessitated by an unlooked-for erosion of the bank, the shore line finally assuming an alignment that it was deemed important to hold, especially in its lower position. The length of revetment, and therefore in this case the location of the root, were fixed by the amount of money available.

The style of revetment adopted was an extreme type of the "lace" or thin mat. July 25 work was begun. The mattress-boat was placed in position at the starting point, facing the bank. One hundred feet of netting, 85 feet wide, with meshes 2½ feet by 5 feet, were made by the machines and drawn out on the bank. This was filled with brush and securely staked, the upper edge being weighted with bailed rock. The boat was then swung out about the lower inside corner as a center until it had assumed a position normal to the bank line, thus weaving a quarter-circle of netting, the cross-wires of which were radii. The dogwood brush was woven in as the netting paid off. Poles 6 to 8 inches in diameter were lashed to it, in position normal to the bank line, as stiffeners, and from these wire bridles led to deadmen on shore about 300 feet up stream. The whole was kept afloat by barrels until the boat had proceeded as far as desirable down stream, when it was weighted with rock and allowed to sink into place. The brush was taken from a "tender" on the up-stream side of the working boat, and woven in the netting across the ways, tops to the bank, 12 cords being used to fill 100 linear feet, or 9.000 square feet. After a few hours in the water the mat would sink without the aid of rock. About 1½ cubic yards to 100 linear feet were put on to insure contact with the bottom. It was bailed and attached to wires leading out across the mat from stakes on shore.

The netting, which reached nearly to the top of the bank, was made fast by wires to stakes driven 5 feet apart. The meshes were left open to the water's edge, to facilitate grading, which was done after the low water mat was laid.

At the start 4 minutes were required to make one fleet (20 feet) of netting, and 22 minutes to fill it with brush. These were soon reduced to two and a half minutes for the netting and nine minutes for the brush. The average day's work of ten hours was 504 feet; the maximum was 400 feet in five hours. The cost per linear foot in place was 28.9 cents. Forty-five hundred and seventy-five feet of this revetment was put in. The low water mat was finished August 5.

As a temporary revetment this style is recommended for cheapness, rapidity, and ease of construction, and prompt efficiency. It will be noted further on, however, that the efficiency diminishes rapidly with age.

REPAIRS TO BOATS.

While we were waiting the arrival of the grading boat from Lexington the fleet of boats was dropped down to Glasgow for repairs. All of them were recalked; the three-decked flats used for towing were given a shear of 8 inches at one end, and the derrick boat was redecked.

HYDRAULIC GRADING.

This work was begun September 27, the plant used being grader No. 2. Several changes in the appliances for the delivery of water were contemplated, but with the exception of the attachment at the shore end of the boom, none of them were completed in time to be used.

The water was delivered from the pump through a piece of 6-inch hose, 10 feet long, to the derrick-boom, a 6-inch iron pipe 32 feet long. On the end of the boom was fitted a Y casting, from which, through two sections of 2½-inch hose, respectively 50 and 60 feet long, the water was carried to the bank.

It was found that one hundred and twenty displacement per minute was as fast as the pump could be worked without distress to some of its parts. This gave a pressure at the pump of 90 pounds and nozzle pressures of 50 to 65 pounds. Under these limitations the maximum results were obtained with 1¼ and 1½ inch nozzles. The method of working the stream was the same essentially as described in my report for last year.

The higher prices of labor which obtained this year, together with a very low efficiency of pump, combined to raise the cost per cubic yard of material moved above that of last year. A comparison is drawn in the following table:

Year.	Number displacements.	Pump pressure.	Discharge per minute.	Nozzlemen.	Laborers.
			Gallons.		
1880	280 to 376	90 to 130	489 to 630	17½ cents per hour.	15 cents per hour.
1881	120	90	428	$60 per month....	17½ cents per hour.

October 7 the grading boat was sent to Saline City to aid in pumping out the United States snag-boat H. G. Wright. Work was resumed October 12.

November 1 one of the piston-rods broke, causing a delay of seven days. The grade was completed November 9. The plant was sent to Jefferson City November 13.

The question has arisen as to whether the grading should be done before or after the low water mat is laid. When equally convenient the former should rule, as more or less damage will accrue to the revetment by breakage of bank-wires and slipping out caused by the semi-fluid mass of tailings. Ordinarily, however, other conditions will govern.

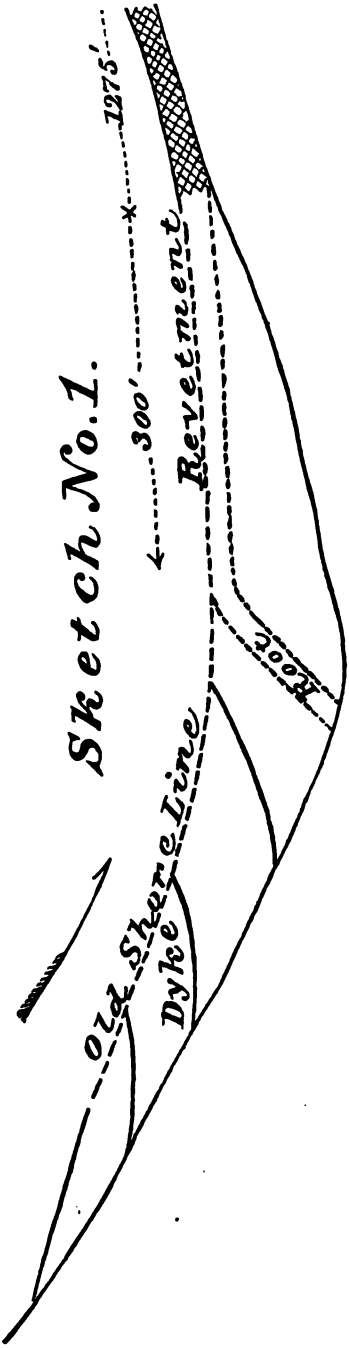
A point which is yet involved in doubt is the most economical application of the discharge. With a given discharge—other things being equal—the cost of grading by the hydraulic process will vary largely with the size and number of jets used, and their manipulation.

A given discharge concentrated in one stream is economical in point of frictional resistances and erosive power. If the same discharge is divided into a number of streams the frictional resistances are increased, but a greater economy of water (the ratio of the material moved to discharge) is possible by reason of freer handling of the jets. As an instance, close to the limit, it is thought that with a total actual discharge of 600 gallons per minute better results would be possible with two streams than with one.

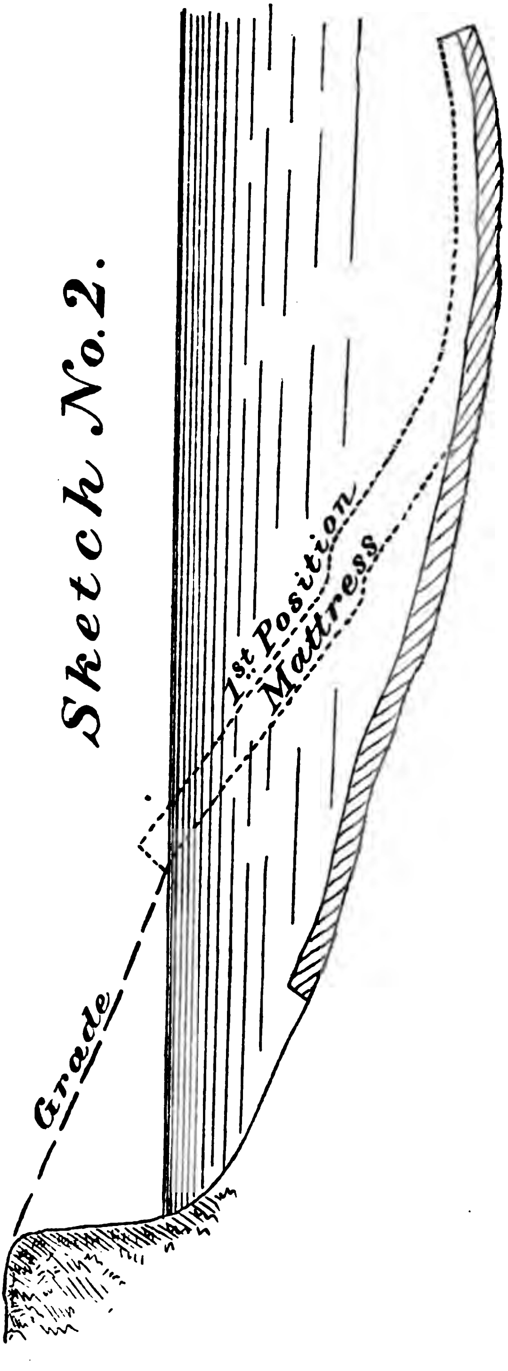
BUOY-DIKES.

Middle Bend.—About November 4 the bank began caving immediately above the foot of the revetment in this bend, and it soon became necessary to afford some protection. As the best means practicable at that time, it was decided to put in a series of buoy dikes, designed to hold the current out to the old shore line.

On a temporary machine constructed for the purpose, eight pieces of netting 45 by 80 feet were made. The area of mesh was reduced from 3 square feet to 1 square foot by willow brush woven in horizontally. They were placed in position, about 225 feet apart, extending out from the shore down stream at angles with the axis of flow vary-



Sketch No. 1.



Sketch No. 2.

ing from 10° in the upper to 60° in the lowest, the latter being located just above the revetment. This work was begun December 6 and finished December 8.

SURVEYS.

The following surveys were made during the year:

July 12, shore lines Middle Bend and Shore Bar.

September 1, connected by triangulation the Morrison Observatory with the Missouri River Survey. September 15 to October 8, complete survey, including triangulation of Missouri River from Brunswick to Cambridge.

October 10 to 22, complete survey, including triangulation of Missouri River from Glasgow to Arrow Rock.

December 9 to 23, survey of Missouri River from Cambridge to Glasgow. This survey included, besides shore lines and soundings, topography in detail, slope, and approximate discharge.

In addition to the above-mentioned surveys, other work bearing on the physics of the stream was done from time to time.

Since January 1, 1882, operations have been confined chiefly to the office. All of the survey work has been platted, and models of some of the appliances have been made.

February 28 the office at Glasgow was closed. All the employés except the water-gauge observer and a watchman in charge of the steamer Electra were discharged. Subsequently the watchman performed the duties of both. I reported to you for duty at this office on March 2.

August 15 information was received that the revetment in Middle Bend was giving way. There were no funds available for repairs, and the stage of water was too high at that time to determine the nature or extent of the damage done.

May 11 an examination was made and the following notes taken: From the root down about 300 feet no trace of the mat was found. (See sketch No. 1, page 1686.) From there down 1,275 feet the revetment was intact.

For the length remaining, 3,000 feet, the bank had cut back to the top of the grade, and the mat was found to be lying on the bottom. (See sketch No. 2, page 1686.)

It will be remembered that when first placed, the mat, though very open, was frouzy, presenting a depth of section about 3 feet to the current. Apparently the section had been reduced to about 6 inches. This may have been effected in part by a loss of the smaller branches of brush from attrition, and in part by a limpness or loss of elasticity in the brush, due to constant strain under water.

At all events, for so open a mat, the original thickness was none too great, and it is to the reduction of it that we must attribute the failure of the revetment. Such constructions should therefore be used only as temporary expedients.

The general alignment of the reach from Cambridge to Glasgow is still good, but it is very important that the shore line of Middle Bend be held by a permanent revetment from Cambridge to the shore bar. Delay in this work may defeat the project.

I have the honor to be, major, very respectfully, your obedient servant,

S. WATERS FOX,
Assistant Engineer.

Maj. CHARLES R. SUTER,
Corps of Engineers, U. S. A.

S 5.

IMPROVEMENT OF MISSOURI RIVER AT LEXINGTON, MISSOURI.

Work during the past season at this locality was directed to the protection of the left bank of the river, opposite Lexington, the rapid erosion of which had nearly destroyed the harbor of that town. The work was very light and of temporary character, the amount of funds available not admitting of anything more substantial. Nevertheless the desired object was accomplished, and this year it is expected that the work will be thoroughly secured, as it comes within the limits of the reach selected for work under the general project of improvement.

The work has been in charge of Assistant E. C. Shankland.

The work is situated in the collection district of New Orleans, and the nearest port of delivery is Saint Louis, Mo.; nearest fort is at Leavenworth, Kans.

Amount of revenue collected at the port of Saint Louis, Mo., during the fiscal year ending June 30, 1882, was $1,676,951.56.

Money statement.

July 1, 1881, amount available	$14,383 70
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	14,312 34
July 1, 1882, amount available	71 36

REPORT OF MR. E. C. SHANKLAND, ASSISTANT ENGINEER.

LEXINGTON, MO., *July* 3, 1882.

MAJOR: I have the honor to submit the following report of operations at Lexington, Mo., during the fiscal year ending June 30, 1882.

The work has been carried out in accordance with the project submitted June 17, 1881.

Hydraulic grading of the bank opposite Lexington, begun June 13, was continued, and finished September 7. The work progressed slowly, as the plant was new and untried, and the men unskilled. August 8, a double force was put on and the work prosecuted night and day.

The grading plant consisted of a boat 100 by 24 feet, with machinery as follows: A Worthington duplex compound steam-pump, steam-cylinder 12 by 18¼ inches in diameter, water-cylinder 10½ inches, and stroke of 10 inches, with steam-pipe 2 inches in diameter; exhaust-pipe, 3½ inches; suction-pipe, 7 inches; and discharge-pipe, 6 inches; a horizontal five-flue boiler, 42 inches in diameter and 26 feet long, with flues 10 inches in diameter; shears for snagging, and two derricks for carrying hose.

Six-inch hydraulic hose was used, and nozzles varying in size from 1 9/16 inches to 2 3/16 inches were tried. The 1 5/16-inch nozzle gave the best results in this soil. The pump was worked at seventy-five strokes per minute, and a pressure of 75 to 80 pounds, the boiler pressure being 80 to 90 pounds.

The bank graded was heavily timbered. It is composed of a top layer of black soil, overlying a stratum of hard blue clay from 3 to 8 feet thick. Below the clay and extending below the water surface is a layer of sand. The bank has an average height of 13 feet; it was graded to a slope of 3 on 1, making a little over 9 cubic yards of earth removed per linear foot.

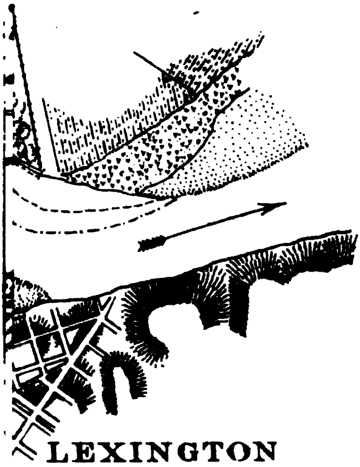
There was graded 4,855 feet of bank, or 44,370 cubic yards of earth was removed, and at a cost of 2¼ cents per cubic yard. Grading with shovel and scraper on the same bank cost 12¼ cents per cubic yard. The amount of earth removed per bushel of coal burned was 14¼ cubic yards. The best day's work was 144 feet, equal to 1,214 cubic yards in twelve hours.

The boom of the derrick for carrying the hose was made of 6-inch iron pipe, and the hose connected to the outer end. On account of the stiffness of the hose, and the inner end of the boom being so close to the pump, but little play could be given to the derrick. This made it necessary to work directly at the breast instead of from the top of the bank, which would have been preferable in some instances.

The work was considerably delayed and the cost increased by the heavy timber on the bank. In addition to the time lost washing out the stumps, it was necessary to employ an extra man as axman to cut the roots, &c.

In July a buoy screen dike was begun at Gordin's coal chutes, about 3 miles above Lexington, on the right bank. About 500 feet were put in, when the water reached such a low stage that the work was ordered stopped. This dike, however, caused a fill immediately behind it, where the water was 15 feet deep, of from 6 to 8 feet, and its effect was visible for 1,000 feet downstream.

The revetment of the bank opposite Lexington was begun as soon as the grading was finished. The revetment used was the woven mat similar to the one used the previous season. It was 80 feet wide, and 3,159 feet were put in, at a cost of 19 cents per linear foot, including cost of wire. Five hundred and forty-four linear feet were put in in 8¼ hours, with a total force of twenty-three men.



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The wire net was made on the river bank at Lexington, in sections 40 feet square. Five of these were put on a roll, carried to the mattress boat, and there unrolled and sewed together. One cord of brush was used to 8 linear feet of revetment, and 1 yard of rock to 25 linear feet. The brush used was heavy, mostly dogwood, so but little rock was necessary.

It was found that the cutting of this bank in former seasons had always begun at the same point, about 2,000 feet below Willow Creek. This was owing to the fact that this place had received the full force of the current during a greater part of the year; also, that the lower stratum was a fine white sand easily acted upon by the water. Thus was undermined the bank above it. It was, therefore, deemed necessary to put in a high water protection only at this place, and put hurdle-fences or some other inexpensive device over the rest of the bank.

Accordingly a closely-woven willow mat 40 feet wide and 600 feet long was put down, staked securely, and fastened at the lower edge to the revetment. It was covered with from 4 to 6 inches of earth. Cold weather coming on, no other protection was put on the bank last fall. This spring the willows in the mat took root, and are now growing thickly all over the bank, thus adding to the security and strength of the protection.

The high water protection cost 50 cents per linear foot. One cord of brush was used to 11¼ linear feet, and 1 yard of rock to 10¼ feet.

The April rise did not cause any cutting of the bank, and it is believed that it will resist the action of the June rise equally well.

The dikes at Gordin's contemplated in the project should have been put in this spring, but the appropriation was too nearly exhausted to allow it, and no more work has been done thus far this season.

A map of the reach, showing shore lines of 1878, 1880, and 1881, is transmitted with this report.

Very respectfully, your obedient servant,

E. C. SHANKLAND,
Assistant Engineer.

Maj. CHARLES R. SUTER,
Corps of Engineers, U. S. A.

S 6.

IMPROVEMENT OF MISSOURI RIVER AT KANSAS CITY, MISSOURI.

At this locality work during the past season was confined to bank revetment in the bend below Quindaro; the object being to prevent change in the direction of the channel in entering Kaw River Bend. This work was successful. Further operations at this important locality will be done under the general project, as this portion of river lies within the reach selected for the initiation of the work.

The work during the past season was in charge of Assistant John W. Neir.

The work is situated in the collection district of New Orleans, and the nearest port of delivery is Omaha, Nebr. The nearest fort is Leavenworth, Kans.

Amount of revenue collected at Omaha, Nebr., during the fiscal year ending June 30, 1882, was $4,525.82.

Money statement.

July 1, 1881, amount available	$23,912 61
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	23,861 34
July 1, 1882, amount available	51 27

REPORT OF MR. J. W. NEIR, ASSISTANT ENGINEER.

KANSAS CITY, MO., *July* 12, 1882.

MAJOR: I have the honor of submitting my report for the year ending June 30, 1882.

The months of July, August, and September were spent in a careful and extended survey of the reach, to ascertain and determine the character of changes in the channel induced by the disastrous spring flood of last year. The condition of the old work was found to be about the same as reported last year.

The upper end of the old revetment has given way, owing to heavy pressure upon it, induced by radical shifting of the channel upon Line Creek Crossing. Otherwise the work is doing well and the original bank line is maintained, although the upper bank work has long since disappeared.

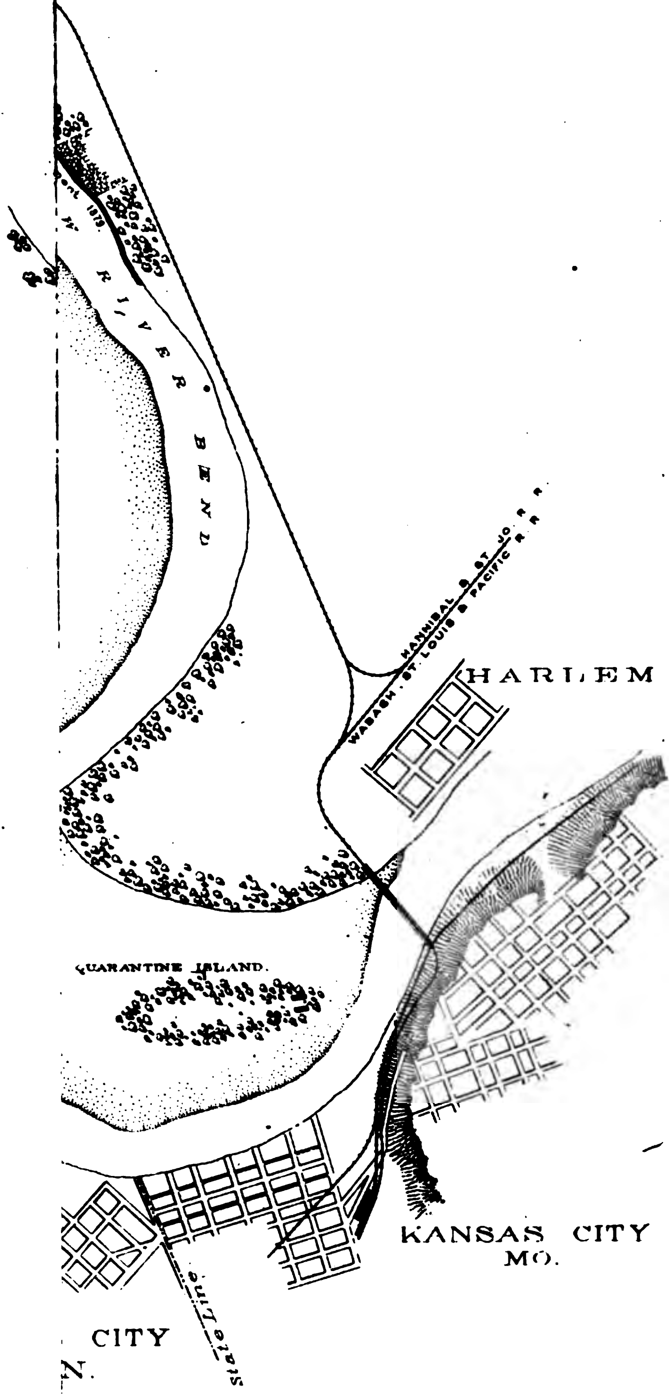
The action of this flood upon free concave banks can be imagined, as there was a uniform cut varying from 300 to 800 feet. During the year the river has encroached upon the neck north of the bridge about 500 feet, reducing its width to about 3,000 feet. At the present rate of erosion five years will suffice for the river to cut through and isolate the bridge. Very general work from Quindaro to Wyandotte, carried on during a single season, can alone avert the danger. The cramped position which the river occupies in Kaw River and Kansas City bends seriously complicates the case. The valuable interests of both navigation and the community require that heroic treatment be resorted to to prevent the river from forming a cut-off at this place. Disjointed work scattered over a distance of 7 miles, of such character and extent as the funds available would allow, has not, up to the present time, placed the river under control upon this reach.

In view of past experience, it was deemed best to commence a systematic line of training and revetment work at Quindaro and carry the same in a continuous and unbroken system to Wyandotte. Accordingly a revetment upon the right bank below Quindaro was commenced and pushed as far as possible. The impassable character of the river bottoms, owing to the overflow, prevented the resumption of work until late in the fall, when material could be more readily transported. The lateness of the season, coupled with a delay in the completion of the wire-net apparatus, considerably reduced the amount of actual work done below that contemplated. The prevalence of contagious diseases in the vicinity of the work compelled the transportation of the entire working force to and from Wyandotte each day, thereby reducing the working hours to between six and seven. Many of the roads being quarantined in that locality, nearly all brush used had to be procured opposite and below Kansas City, and transported several miles up stream upon a complement of barges wholly inadequate to such contingencies. Under these disadvantages the progress of work was very slow until the river closed with ice, up to which time 3,035 feet of revetment had been constructed.

The revetment had a uniform width of 72 feet and a thickness of about 2¼ inches. The methods of construction and apparatus used are briefly described as follows: The mattress consisted of willow brush woven into a wire net, the meshes of which were hexagonal in form. A system of weaving introduced upon this work in 1879 was again employed on account of its durability and ease of construction. To obviate the danger that might arise from the deterioration of the wire netting, the brush was given a bond in itself. Until some coating is given to wire that will protect it against deterioration by corrosion and attrition, too great reliance cannot be placed upon it. It was here employed only as a temporary basis of strength, its period of usefulness terminating when the mattress was in place.

The netting was made as fast as it was wanted, by a simple machine placed upon the down-stream side of the boat, the boat being placed across the current, with the mattress playing off the upper side as fast as completed. A set of low, flat ways placed 4 feet apart, with a platform 12 inches below their upper surface, served to weave the brush upon. This operation was very simply and rapidly done by laying several courses of straight brush parallel to each other and pushing brush into position over and under those first placed. The netting was in this way thoroughly worked into the mattress, and made it very strong. As fast as the mattress was slipped from the boat, a hard variety of siliceous limestone was thrown upon or wired to it, as the case required.

The wire-net machine employed is a very simple appliance. It consists of a series of gas-pipe shafts placed parallel to each other, 16 inches apart, and in a horizontal plane. These shafts have ordinary gas-pipe Ts screwed into them, the open ends of which hold short nipples of gas-pipe. Upon alternate shafts spools or bobbins are slipped in pairs with the wires leading across the boat. A twist of the wire is given by a crank attached to the end of each shaft, and the bobbins are slipped upon the shafts previously idle. In this manner the mesh is readily made. The machine also


ont 1879.
RIVER BEND
HANNIBAL & ST. JO. R. R.
WABASH, ST. LOUIS & PACIFIC R. R.
HARLEM
QUARANTINE ISLAND.
KANSAS CITY
MO.
CITY
State Line

possesses a feature of permitting the introduction of wire-rope longitudinally, to add strength when extra strains are placed upon the mattress in heavy currents. The size of mesh was 40 by 32 inches, the sizes of wire commonly used being Nos. 12 and 14, which were strong enough in ordinary cases.

The speed attained in mattress construction during the past year is quite satisfactory. From 22 feet per hour, the highest speed attained on a woven mattress at this place in 1879, we have increased to 128 feet with a force of forty-five men. The greatest day's work was 500 feet in five and a quarter hours. The full working capacity of the plant could not be determined, since sufficient material could not be delivered for a day's supply ahead. With no accidents or delays the capacity of the equipment would probably be from 800 to 1,000 feet per day of ten hours.

Six men manufactured all the netting required and wound the spools with wire. The capacity of the net machine is about 3,000 feet per day with six men on a net 72 feet wide. The grading apparatus not being available, the work of bank grading was deferred until spring. It was intended that grading should commence on March 1, but as the boat was ice-bound at Saint Joseph, work was not begun until late in the month, when, by accident, the work was brought to an abrupt close. The grading boat, while in use, proved to be a labor-saving machine. Four hundred linear feet of bank were graded in seven and a third hours, with the pump and boiler out of repair. The grade of bank was 3 on 1. the height of bank being 20 feet above low-water line. Upon a homogeneous bank, 400 feet per day of ten hours would be an average day's work, when the pump was in thorough repair. Our experience with the grader here can scarcely be considered as a guide in future operations. The pumps were in a bad state of repair, and did not throw over 70 per cent. of the pump capacity when in good repair. Special styles of pumps, adapted to the pumping of gritty water, must be used to get the best results. The proportion of material moved to coal consumed was very good, being 40 cubic yards of earth to 1 bushel of coal.

During the year a pile-sinker was built, by your orders, and in general conformity with the plans of the board on pile-sinking. Upon completion, in July, she was accidently sunk while in tow of the steam-launch, and finally raised, after five days' work, out of 33 feet of water. Repairs upon the boat necessary to put her in working order were promptly made. Two barges, 96 feet long and 16 feet wide, were also built as a part of the working plant to be used in future operations. Material has become scarce in the vicinity and in future must be transported upon barges several miles. The present plant is too small to prosecute work with the speed that time and economy demand.

During the past winter a low-water survey from Pomeroy to Sibley Landing was made by my assistant, T. W. Young.

In viewing past operations, covering a period of three years, I am satisfied that the original plans for the completion of the work were well laid. The methods adopted have proved satisfactory in a high degree, and it is only a matter of regret that the work could not be carried out to an extent commensurate with its importance.

In conclusion, I wish to acknowledge the aid of my assistants, M. A. Diaz and T. W. Young, and foreman A. A. Clapp. It becomes my duty to inform you of the death of Capt. George Burruss, of the steamer Sabrina, whose services were highly satisfactory.

For drawings of net apparatus and mattress appliances, I would refer you to specia report upon that subject under date of January 9.

I am, major, very respectfully, your obedient servant,

J. W. Neir,
Assistant Engineer.

Maj. Charles R. Suter,
Corps of Engineers, U. S. A.

S 7.

IMPROVEMENT OF MISSOURI RIVER AT FORT LEAVENWORTH, KANSAS.

During the past season an unsuccessful attempt was made to repair, at least temporarily, the extensive damage which was caused to the works in this neighborhood by the disastrous spring floods of 1881.

The funds available were entirely inadequate for the work required, and the light revetment put in failed to effect the desired object.

Henceforth operations at this point will be carried on under the general project for the improvement of the river, as it is included within the limits of the reach selected for initiating the work. During the past season the work has been in charge of Assistants G. T. Nelles and G. E. Thackray.

The work is situated in the collection district of New Orleans, and the nearest port of delivery is Omaha, Nebr.

Amount of revenue collected at Omaha, Nebr. during fiscal year ending June 30, 1882, was $4,525.82.

Money statement.

July 1, 1881, amount available	$11,279 57
Amount received from sale of fuel to officers	39 37
	11,318 94
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	11,279 88
July 1, 1882, amount available	39 06

REPORT OF MR. G. T. NELLES, ASSISTANT ENGINEER.

ATCHISON, KANS., *June* 15, 1882.

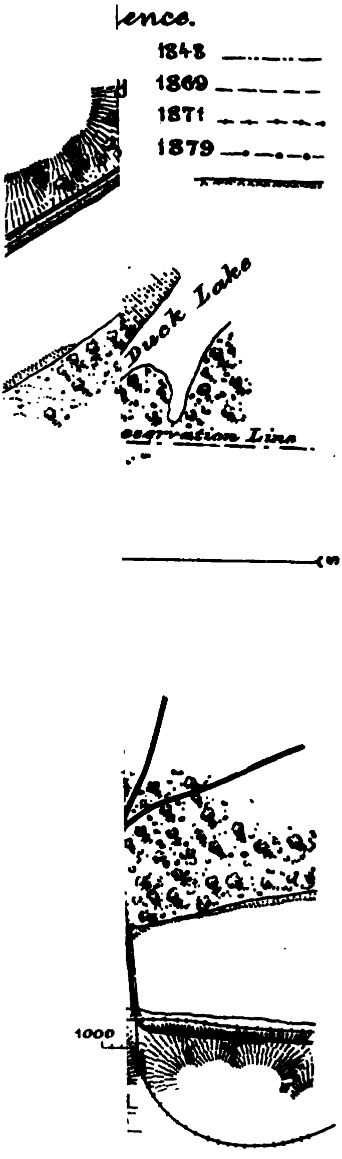
MAJOR: I have the honor to submit the following report of operations at Leavenworth, Kans., carried on under my charge, between July 1, 1881, and February 1, 1882. At the last named date I was relieved by Assistant G. E. Thackray, who had previously been my assistant as local engineer.

Work on the dike above the mouth of Bee Creek, in course of construction at the date of my report for the fiscal year ending June 30, 1881, was continued until the receipt of Special Order No. 30, July 14, 1881. Up to that time about fifty piles had been placed, covering a distance of 700 feet. The netting had been suspended for the first 300 feet. The dike, being directly across the channel, had to stand against the drift pressure and the deep-channel scour, which was greatly increased in depth by the retardation caused by the drift accumulation at and near the water surface. These causes combined to greatly increase the cost of the dike above the estimates. The lateness of the season made the results to be obtained very uncertain. The piles and netting put in, although they had a marked effect on the surface, caused no fill or gave rise to no action that would indicate the final success of the work, except by a long and stubborn resistance to the direct flow of the river into the bend. After taking all these points into consideration, Special Order No. 30 was immediately acted upon by stopping all work on the dike.

There is no doubt, in my mind, but that a properly-located dike, put in before the spring rise, will cause the deflection of the main channel into the Kansas Chute. The main trouble with the dike attempted was, that it was not properly located, in that it crossed the channel too abruptly. It was attempted to force the desired results by means not at all calculated for such work. A very much more acute angle with the current and a greater length would probably have been easier of construction and more successful.

A few favorable indications followed the construction of this work, among which were the permanent enlargement of the Kansas Chute and an extensive cut along the Kansas bank.

After deciding that the dike was impracticable at this season, and in view of the necessity for some protection in the bend in order to save the mattress work already put in from being extensively cut out, work was immediately commenced on a thin, continuous revetment, 70 feet wide, starting from a header in Bee Creek and extending down stream to connect with the old work. Wire was used as a basis of strength and dogwood brush woven into it; a total of 5,400 feet, 70 feet wide and one-third



nworth

foot thick, was placed at a cost of 70 cents per linear foot, or $1 per square of 100 square feet. Considered as a temporary protection, this work was a decided success. The cutting, which was excessive before the placing of the revetment, ceased with the advance of the work. It has all cut out since, however. For a full description and report on this work, I respectfully refer to special report dated May 26, 1882. No constructions were attempted after the completion of this work.

During November a survey was made extending from Geary City to Pomeroy. As the expense of this survey was equally divided between Atchison and Leavenworth appropriations, it will be made the subject of a special report.

Very respectfully, your obedient servant,

G. T. Nelles,
Assistant Engineer.

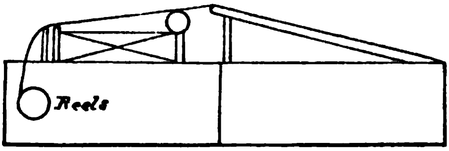
Maj. Charles R. Suter,
Corps of Engineers, U. S. A.

Atchison, Kans., *May* 26, 1882.

Major: I have the honor to submit the following special report on the revetment placed during the past season at Leavenworth, Kans.

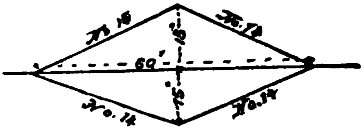
The necessity for a protection calculated to give immediate results and the limited amount of the balance available led to the adoption of a thin mat with wire as a basis of strength. The necessity for immediate action did not allow time for the design and construction of special plant.

A barge 75 feet by 12 feet was fitted with ways 13 feet long and 3 feet apart, and used in conjunction with a boat of similar size fitted with an apparatus for making wire netting of any desired size of mesh and 70 feet wide.



The arrangement of the boats is shown by sketch and by accompanying artotypes from photographs while in active operation.

The boats were held in position by means of long lines made fast to the bank, and manipulated by means of two Perley half windlasses. The work was commenced with a header 75 feet wide, extending 150 feet into Bee Creek, made by weaving willow brush to a thickness of 10 inches into a small mesh netting. This header was well weighted with rock to prevent damage from freshets in the creek. From this header the work was continuously extended downstream 70 feet wide, and of sufficient thickness to hide the boat, by weaving dry wood brush into a wire netting. A triangular mesh was at first used, 60 by 15 inches, with No. 14 wire for sides and No. 12 for base.



Later the size was increased to 60 by 30 inches. This size proved too weak, and a mean size, 60 by 20 inches, was adopted and used during the latter half of the work, with a No. 9 wire for a base instead of No. 12.

The mat was put in while the river was still up, and considerable trouble was caused by drift. By this cause alone the cost was increased at least 30 per cent., and the speed of placing decreased 50 per cent. It was frequently necessary to spend one-half a day to repair the damage of the preceding night. The drift damaged the work either by tearing great holes in the mat, or by parting it at the boats when it would hold the accumulated drift.

No high bank protection was used. The inner edge of the mat was made fast to stakes in the bank, by means of No. 9 wire, every 10 feet.

Five thousand four hundred feet of mat 70 feet wide was placed, or 3,780 squares of 100 square feet. The following is the distribution of material per square:

Brush, 900 cords total, or 0.24 cord per square.

Stone, 115 yards total, or 0.03 yards per square.

Wire, 12,500 pounds total, or 3¼ pounds per square.

The stone was made fast to the outer edge of the mat and paid out with it. None was thrown on the mat.

Speeds ranging from 20 to 80 feet per hour were made. The highest, 80 feet per hour, was maintained long enough to show that under favorable circumstances and with a specially designed plant it could be maintained as the regular rate. The maximum total day's work was 400 feet. The labor, making netting and weaving mat, varied from 26¼ cents per square, the actual cost for the whole work, to 12¼ cents per square, for maximum day's work, and 7 cents per square for the maximum hour's work. The approximate total cost of the work was 70 cents per linear foot, or $1 per square. Labor was scarce and wages very high, which caused an increase of 12½ per cent. for labor over any other work done by me.

When work was commenced, cutting was taking place throughout the whole length of the unprotected portion of the bend. This ceased entirely with the advance of the work. The severest cut was always immediately below the boats. The obstruction to the current offered by the suspended mat and the boats caused an eddy to form behind them, which would work its way upstream and cut out a pocket at the shore end of the boats, into which they would drop and cause much serious delay in starting the following morning. The end of each day's work was almost invariably marked by one of these pockets. Although the cutting stopped after the mat had been placed, soundings over the mat showed a scour through it, which, although it caused no immediate damage, was eventually the cause of the destruction of the mat. The material scoured out would be replaced by small slides from above it, which, in its turn, being scoured out, would cause a slide from farther up, until, finally, the top bank would be undermined and cave in, either carrying with it the top stakes or breaking the wires holding the edge of the mat to the bank, originating breaks that have since included the whole work.

The nature of the bank throughout this bend is such that it melts like sugar under wave or current action. Wave action doubtless hastened the destruction of the work by causing the top bank to cave into the mat and break it loose from the bank. A high bank protection would have, in a measure, prevented damage from this source and would have increased the life of the work. Still, it is my opinion that work of this nature is at best a very temporary protection.

No data is at hand or has been obtained bearing on the question of bank grading. It has been my observation that a grade of 2 on 1 stands very little or no better than a grade of 1 on 1 under the same circumstances, and with the same protection. I have also observed that, other things being equal, the efficiency of a high bank protection depends on its power to resist wave action, and that stone offers the most lasting and efficient resistance to such action when used plentifully in conjunction with a brush protection.

Very respectfully, your obedient servant,

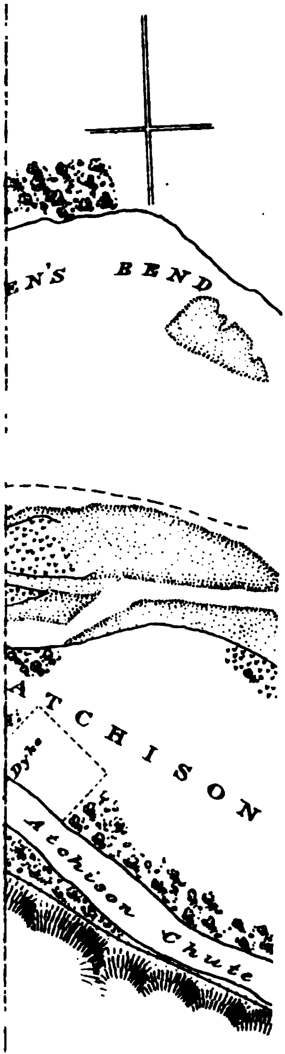
G. T. Nelles,
Assistant Engineer.

Maj. Charles R. Suter,
Corps of Engineers, U. S. A.

S. 8.

IMPROVEMENT OF MISSOURI RIVER AT ATCHISON, KANSAS.

During the past season work at this point was confined to the construction of permeable dikes designed for channel contraction and regulation. They were composed of wire netting supported on pile bents or on tripods. Great difficulties were met with in their construction, due to high-water and drift, and they required and received con-

EN'S BEND
ATCHISON
Dyke
Atchison Chute

siderable repairs; nevertheless, they were maintained and promise to yield results of value.

Further work at this point will be under the general project, being included in the reach selected for the initiation of work.

During the past season the work was in charge of Assistant G. T. Nelles.

The work is situated n the collection district of New Orleans, and the nearest port of delivery is Omaha, Nebr. The nearest fort is at Leavenworth, Kans.

Amount of revenue collected at Omaha, Nebr., during the fiscal year ending June 30, 1882, was $4,525.82.

Money statement.

July 1, 1881, amount available	$22,997 14
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	18,810 00
July 1, 1882, amount available	4,187 14

REPORT OF MR. G. T. NELLES, ASSISTANT ENGINEER.

ATCHISON, KANS., *June* 23, 1882.

MAJOR: I have the honor to submit the following report of operations under my charge for the improvement of the Missouri River at Atchison, Kans., during the present fiscal year.

Owing to unavoidable detention at Leavenworth with the joint plant, no field construction was undertaken during the fall of 1881.

After consultation with you it was decided to wait until early spring; and then, by having everything in readiness, to do our work in time to take full advantage of the spring rise.

In October, 1881, acting under your instructions, a low water survey of the reach extending from Geary City to Pomeroy, a distance of nearly 60 miles, was commenced. A special report of this survey has been submitted to you.

Late in January, 1882, while in Saint Louis, I laid before you my project for the season's operations, which, with your approval, was carried out later. On my return contracts were let for poles and stone as follows:

1,200 cottonwood poles, 30 feet long and not less than 4 inches at the top, at 35 cents each.

1,000 cubic yards of stone at 60 cents per yard.

On account of the cold weather and the amount of ice running in the river, the plant could not be brought from Leavenworth, where it had been during the winter, so that it was not until March 1 that work was actually commenced.

The project approved called for the following work: A tripod and screen dike at the head of Atchison Island, and three cross-dikes of similar construction in the Atchison Chute. This work was expected to confine all the water to the main channel and to throw the river during high water into McQueen's Bend. Another dike was projected at the lower end of the bend, which was intended to deflect the river and hold the channel in to the Kansas side, and thus insure a channel under the draw of the Atchison bridge. The above project, which was carried out, is indicated on an accompanying tracing.

This project was based on the fact that while the river took McQueen's Bend, the required conditions existed at the bridge, but when the channel cut across the bend it followed down the Missouri bank and under the east span of the bridge. It was anticipated that the work would, to a certain extent, continue the low water condition of affairs during the higher stages and build up the bars, so that more permanent and effective work could be put in when more means were available for the purpose. In short, it was proposed to confine the river to one channel for all stages, and that channel was to be the actual low water channel. The local interest, backed by the fact that in November, 1880, a bar had formed under the draw span of the bridge, which had delayed a steamboat several days and had threatened to hold her all winter, made necessary a project which had in view the prevention of another such catastrophe. The resulting width, length, and cross-section were to be in accordance with the general plans for the improvement of the river.

The manner of doing the work was decided upon for economic motives and for a desire to make the balance available go as far as possible, and still leave enough money on hand to follow up the results obtained.

The tripods were constructed of poles, 30 feet long and 4 inches in diameter at the top. The intersection was placed 20 feet above low water and the base made from 10 to 12 feet. It was originally intended to sink the feet of all the tripods with the pile-sinker to such a depth as to insure their safety from scour. Owing to the various difficulties in working the pumps in shallow water, it was found necessary, in order to complete work in time to take advantage of the April rise, to set a great many tripods with shovels, and a depth of 6 feet was reached in this way. Where it was possible to get to the work and use the "pile-sinker," rapid and satisfactory progress was made. The poles were started in holes 2 feet deep, dug with shovels, into which the water was forced through a long gas-pipe nozzle, which was operated by two men and was entirely free from the poles. The pole was shaken and twisted by two or more men and rapidly settled into the hole made by the jet. The poles sunk equally well in dry sand and in submerged sand. A speed of one hundred poles per day was frequently obtained, but, owing to frequent breaks in the conducting hose (condemned city fire-hose borrowed for this work), and to the frequent stoppages of the pumps by sand, &c., in shallow water, we were obliged to work under a very light pressure and with great caution. Consequently the average speed for the whole work was very low, and affords no criterion of what can be done under more favorable circumstances. The netting for this work was all made at Saint Joseph, Mo., on the machine designed and built by Assistant Engineer D. W. Church. It was made 30 feet wide, with square meshes 2 by 2 feet and entirely of No. 12 steel wire; 16,033 feet were made in all, at a cost of 8.8 cents per linear foot and 29⅓ cents per 100 square feet. A detailed statement of cost appears later in this report.

The netting was made fast to a five-eighths-inch wire cable at each intersection. The cable was then placed over the intersection of the poles and fastened to the tripods. The netting was then hauled taut and an anchorage of about 200 pounds of stone per linear foot wired to its lower edge. Experience has shown that even this weight of anchorage is insufficient to withstand the drift pressure.

The tripods were placed 30 feet apart on all the dikes. A total of nearly 9,500 feet of this work was done, divided as follows: Upper dike, 3,000 feet; lower dike, 4,500 feet; chute dike, 2,000 feet.

While the lower dike was being built the April rise commenced and the highest stage was reached the day following its completion.

Before the river had fallen much the accumulation of drift and the deep scour outside of the dike, caused by a current parallel to it, made two small breaks, which rapidly widened, until, finally, the whole dike was wrecked. The causes of the failure were, insufficient strength of poles, insufficient penetration, and insufficient width of netting for the conditions imposed. These conditions were not at all what had been anticipated and it was not expected that the dike could withstand such conditions. None of the re-enforcing results credited to netting were noticed.

The action of the upper dike was so slow that it was not until after the lower one had gone that it was felt. The upper portion had to withstand the direct action of the current through it, while the lower portion was subjected to a tangential scour. The Missouri Chute which crossed it grew daily, so that after the rise it carried at least four times as much water as it had previously.

The upper dike was not subjected to direct action or heavy strain and, therefore, held, except at the chute end, where it was breached by the drift for a distance of 200 feet.

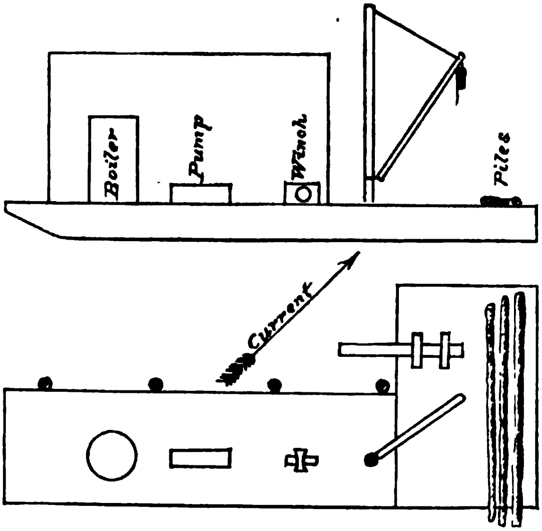
The first and second cross-dikes in the chute were also breached, but the third and last dike held, causing a fill of over one-half the chute cross-section in twenty-four hours.

Immediately after the April rise, work was commenced on a dike near the site of the "lower dike," which was carried out during the high water. The location of this dike is indicated in the accompanying tracing by a double full line (═══).

In order to profit by the experience gained in the preceding work, it was designed to make this dike as strong and substantial as the material and time available would allow. With this in view, A bents were put in, 20 feet apart for the first 1,000 feet, with the intersection 15 feet above low water. The same sized pole as used heretofore was used for this portion, but a penetration of from 12 to 18 feet was secured. For the remainder of the dike, piles, from 30 to 40 feet long and 8 inches in diameter at the top, were used, sunk singly every 15 feet with A bents every 60 feet. Owing to a strata of clay and gravel, which was encountered, no great speed was attained. Specimens of this strata showed it to be about as tough as leather and to contain gravel as large as walnuts. The piles were all forced through this formation, but at a great expense of both time and money, it sometimes being necessary to spend as much as three hours on one pile. An average speed of about seven per day, with a maximum of fifteen per day, was attained. It was thought that the necessities of the case justified this expense, for, unless the piles were forced through this clay, the danger of their being immediately scoured out was great. Once through it they were comparatively safe from everything but the drift. For the outer portion of the dike, an average penetration of 17 feet was secured in from 12 to 16 feet of water.

Until the strata of clay was reached by the pile, a rapid and satisfactory speed was developed by the pile-sinker. Had we been satisfied to stop at this point, the average speed would probably have been between thirty and forty piles per day. When a resistance is met with which keeps the pile or jet in one position for any length of time, the largest and heaviest gravel settle to the bottom of the hole, gradually increasing the resistance until at length the limit of the power of the apparatus is reached. This frequently happened on the work at Atchison, and it was found to be advantageous, after a certain length of time, to pull up the pile and sink it again in a new place, within a few feet of the first hole.

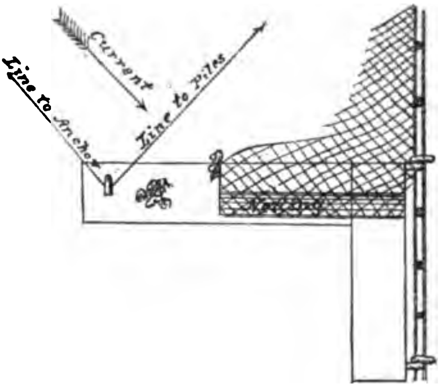
The "turn-table boat," or forward part of the apparatus built here last spring from the Board designs, has not been used at all this season. The derrick alone has been used for handling the piles and placing them in position. A small scow made fast to the machinery boat, as per sketch, was used to work from and to carry material on.



Seven laborers, beside the engineer and foreman, were needed to operate the sinker The jet pipe was passed through a staple near the bottom of the pile, and so arranged that it could be sunk ahead of the pile, or worked up and down independent of the pile, as might be found best. While sinking, the pile was shaken and twisted by hand, and also pulled down with the steam winch. Two hundred piles in all were sunk, at a cost of $1.75 per pile.

As observations on previous dikes showed that the anchors had dragged in every case, a weight of about 200 pounds per linear foot was used on this dike. This held the mattress taut for a long time, but finally proved inadequate to withstand the pressure and the netting bagged down against the piles. The net used was 45 feet wide, with meshes 2 feet square, and of No. 12 wire; it was made fast every 2 feet to an inch cable. The manner of placing and anchoring is shown in the adjacent sketch. [See next page.] Rock was made fast to the outer edge and slid into the river on gas-pipe ways. Almost any desired speed can be attained by this arrangement.

It was hoped to extend this dike 3,000 feet, but a rise in the river put a stop to work when it was only 2,400 feet long. The dike stood well during the first part of the rise and had a marked effect on the river. Outside of the dike the river ran like a race-horse, while anywhere behind the dike one man could handle a skiff with ease. The drift caused such damage to the netting that it became necessary to put in a new net over the outer 2,000 feet, of the dike. From May 14 to 29 there was no noticeable fill; but between the 29th and 30th a fill of from 4 to 6 feet took place along the whole dike except for a distance of 250 feet near the outer end, where there was a considerable scour. This channel enlarged rapidly, until finally it was the cause of a breach 600 feet wide, beginning 1,200 feet from the shore. The breach widened to 900 feet, leaving 1,200 feet of the shore end of the dike, behind which the fill has continued during the rise. The action of the dike is manifest for a mile below by a total absence of current along the Missouri shore. There is also a fill behind the detached outer portion of the dike.



As soon as the pile sinker was taken from the main dike, work was commenced on two particularly strong cross-dikes in Atchison Chute, one at the head and the other at the foot of the chute. Large piles were used and sunk from 15 to 25 feet and 12 feet apart. On the lower dike, when a rock bottom prevented the sinking of piles, several cribs filled with stone were used instead. Netting 30 feet wide was used on these dikes. During the rise in June the upper dike was breached, but the lower one still holds and is doing good work. At one time during the rise a boat could hardly get into the chute at the lower end. It was found necessary to keep a strict watch over this dike, in order to prevent parties owning logs along the chute from cutting it to allow them to pass out into the river. The lower of the dikes, put in during March, which held through the April rise, was cut for this purpose; at least, we can assign no other reason for the break in it.

Of the work put in here previous to my appointment, only that along the Missouri bank above the Atchison bridge remains. This work owes its preservation to the formation of a sand-bar along its whole length, so that it has never been subjected to the direct action of the current. The wave action, during high water, has greatly injured the upper bank protection in places. The manner in which it has stood speaks favorably for the use of large quantities of stone on high bank work.

The surveys and observations during the spring have been confined to the requirements for locating and observing the effects of the dikes. They have extended only from the Atchison bridge to Doniphan.

Ten sections have been sounded eight times in the main river, and twelve in the chute an equal number of times. One slope observation has also been made.

Mr. B. E. Johnson was my assistant on construction.

Very respectfully, your obedient servant,

N. T. Nelles,
Assistant Engineer.

Maj. Charles R. Suter,
Corps of Engineers, U. S. A.

S 9.

IMPROVEMENT OF MISSOURI RIVER AT SAINT JOSEPH, MISSOURI.

During the past season some work was done in the way of repairs to the revetment of Elwood Point, but the main work was done in Bon Ton Bend, the object being to protect the north shore of the French Bottom, where a cut-off is threatened. Both dike work and revetment were under construction, the latter being quite successful.

Further operations at this point will be carried on under the general project, it being included in the reach selected for the initiation of work.

During the past season the work was in charge of Assistant D. W. Church.

The work is situated in the collection district of New Orleans, and the nearest port of delivery is Omaha, Nebr. The nearest fort is at Leavenworth, Kans.

Amount of revenue collected at Omaha, Nebr., during the fiscal year ending June 30, 1882, was $4,525.82.

Money statement.

July 1, 1881, amount available	$27,923 27
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	26,893 68
July 1, 1882, amount available	1,029 59

REPORT OF MR. D. W. CHURCH, ASSISTANT ENGINEER.

SAINT JOSEPH, MO., *July* 8, 1882.

MAJOR: I have the honor to submit the following report on the work of improving the Missouri River at Saint Joseph, Mo., for the year ending June 30, 1882:

The general features of the river in the immediate vicinity of Saint Joseph have not materially changed during the past year. Near the Amazonia Cut-off the stream is rapidly cutting its way towards the Missouri bluffs, and working out a new bend, which, according to present indications, will differ from the Bend Cut-off in 1880 only in being located a little farther down stream. Above Elwood the breaks made in the revetment, by the destruction of the bridge company's dikes, have been extended somewhat, the one at the lower dike being now about 3,000 feet long. At Dike No. 2 the break has not been enlarged much. The wire net suspended in front of the bank in the cutting pocket at this dike is still in place, and although there have been two rises this season, and the river has been at a favorable stage for cutting during the greater part of the spring, there has been no cutting in the pocket. The deposit formed between the buoy line and shore was carried up this season as the water rose, and at the highest stage reached nearly to the surface. Immediately below the netting the bank stands vertically, and is caving. It is impossible to say whether or not the netting has alone been instrumental in holding the bank, but there has certainly been no cutting this season at the same stages at which the bank was rapidly eroded before the net was placed. The end of the old dike stands out of water about 150 feet from shore at this point, and would naturally increase the bank erosion.

The project for the past season's work contemplated the construction of 4,000 feet of screen dike, extending out from the left bank at a point about 10,000 feet below Bon Ton in continuation of the curve of the bend at that point, and the revetment of as much of the left bank between Bon Ton and the proposed dike as the money available would cover. When this project was formed it was intended to complete the dike before the June rise, but on account of delays in the preparation of plans, the work could not be commenced until the crest of the rise had passed. The reasons then urged for going ahead with the dike, notwithstanding the change in conditions, were that as the water receded the current would probably follow more closely the curvature of the bend above, and at the point where the dike was to be located would naturally incline towards the direction desired. In regard to the lack of sediment at a low stage it was thought that the cutting bend above would furnish the necessary material for extending the shore line below the dike, as the material cut away in the bend would naturally be dropped at the first favorable point. These conditions were in no great measure realized. The current did not take the general direction of the bend to the extent expected, and after the dike was started there was very little bank erosion above.

Wire net, cable, and anchors were prepared in July, and on August 1 the work of placing curtains was commenced. The dike was of the ordinary shingled form, composed of wire curtains from 60 to 80 feet wide and from 50 to 60 feet deep, placed parallel to each other and transversely to the direction of the dike at intervals of 50 feet. The curtains were anchored with bailed rock attached to the edge of the netting, and were supported at the air line by barrel buoys every 5 or 8 feet.

The shape of the mesh adopted was that of an isosceles triangle, such as would be formed by bisecting a square along a diagonal. Length of base, 2 feet; altitude, 1 foot. The wires forming the bases all ran parallel to each other and at right angles to the bottom and air lines of the curtain. Most of the net used was made by the pin-twist method, with No. 12 wire for the parallels and No. 14 for the oblique wires. The remainder was machine-twist net, made entirely from No. 14 wire. The edges were strengthened by wire rope made from two to four No. 8 wires.

The curtains were placed on the launching barge in rolls, the buoys already attached forming the core. After attaching the anchors the net was unrolled on the water, and the anchors dropped simultaneously by means of a tumbling rod.

The depth of water varied from about 20 feet at 50 feet from shore to 30 and 34 feet at the outer edge of the dike. In the deeper water several of the curtains were swung around from their normal position and others were badly damaged by submerged drift. In these cases re-enforcements were made as they were needed by placing new curtains more heavily anchored.

Up to the 16th of August twenty curtains had been placed, making a length of 900 feet of dike. At this date the action of the dike was not at all encouraging. Very little fill was shown at any time, and at some dates of sounding a scour was indicated throughout nearly the whole extent.

In order that the deposit formed might be sufficiently high to withstand the next season's April rise, filling ought to have taken place rapidly from the start, and as this had not been the case it was thought best to discontinue the work, unless more favorable results should develop later. Soundings made September 9 showed little additional deposit, and the work was then finally abandoned. Before the season was over the dike was entirely destroyed by drift and running ice.

The experience gained from this work would indicate that, after the June flood has partially subsided, there is not sufficient sediment in the water to produce a deposit rapidly, and that in dikes of the character here used the netting should be made of wire not smaller than No. 10 or 11, and other anchors besides those attached directly to the curtain should be employed.

The revetment for the protection of the left bank below Bon Ton was begun about October 1, at the point where the river leaves the bluffs. It consisted of a continuous woven brush mattress 85 feet wide below the water line and from 35 to 38 feet wide on the upper bank. Willow brush was used exclusively. The low-water mattress was strengthened by a wire-net backing, into which the brush was woven.

Three barges, connected in the form of a catamaran, supported the mattress-ways, giving a slanting surface 34 by 90 feet. This surface was entirely planked over, and way pieces 8 inches high, extending from top to bottom of slant, were placed at intervals of 5 feet. The netting was placed on the boat in rolls 30 feet wide and combined to make up the full width of 90 feet. These rolls were kept at the head of the ways while the netting already unrolled was being filled with brush. They then slid down with the finished mat as the boat was moved, and in being rolled back to the top covered the ways anew. Before weaving commenced the separate widths of net were sewed together.

The netting used was similar to that previously described in connection with the curtain dike. After a quantity left over from the dike had been expended, the base of the triangular mesh was lengthened to 3 feet and 8 inches, the altitude (1 foot) not being changed. The wires forming the bases of the triangles ran parallel with the bank and carried the strain to the boat on normal lines, thereby preventing the mat from shrinking or drawing in towards shore, as has sometimes occurred with hexagonal or diamond meshes. No. 14 wire was principally used, although in part of that left on hand from the dike the wires parallel to shore were No. 12.

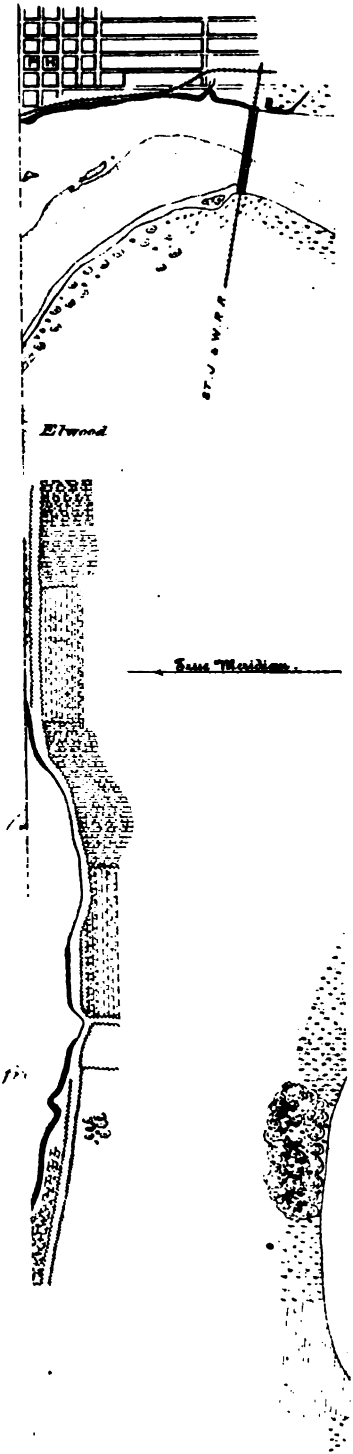
The rock used in sinking was connected in lengths of 60 feet by attaching each stone separately to a No. 8 wire, with intervals between of 1½ feet. This was done to prevent the rock from accumulating at low places on the mat surface or being rolled off by a strong current. The manner of connecting with the No. 8 wire and distributing over the mat was as follows: A No. 12 wire was wound around each stone and twisted up tightly before the rock was loaded for distribution. The loaded barge being brought into position over the mat, a stone was hung on each pin of a gas-pipe tumbling-rod along one side of the boat, and as the No. 8 wire was strung along, the free ends of the wires attached to each stone were made fast to it by twisting. At the point desired the whole was dropped onto the mat by revolving the tumbling-rod. The rock was usually dropped in lines perpendicular to the bank, the other end of the string being near the outer edge of the mat.

The progress made on the low water mat was slow on account of difficulty in getting brush of the kind required and interruptions caused by bad weather and floating ice. The best speed per day was 300 linear feet and the average about 145.

The amount of material used per 100 square feet was as follows: Brush, 0.205 cord; rock, 0.012 cubic yard, and wire, 3.6 pounds. The cost of the mat for material, and the labor of weaving, launching, and sinking, was $1.36 per square, or $1.15 per linear foot.

Eleven hundred and seventy linear feet of mat was lost by the net tearing while passing a projecting point of piling, and by several accidents with running ice.

The steamer Melusina was used for towing brush and stone.



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The bank was graded to a slope of 3 horizontal to 1 vertical, excepting a portion at the upper end, which was 2½ on 1.

Hydraulic grader No. 1, built at Kansas City in 1881, was used for grading the greater part. The pump was a Worthington compound with steam cylinders 12 and 18½ inches in diameter and water plungers 10¼ inches, stroke 10 inches. The water was taken from the pump by a 6-inch hose and carried by a swinging boom pipe 32 feet long, through which it passed to a point on shore. It was then carried by a 6-inch hose 24 feet long to the point desired for directing against the bank. The nozzle attached to the 24-foot hose was supported by a movable trestle and directed by two men, one standing on each side. The arrangement for delivering the stream, thus briefly outlined, was used for some time, but the 24-foot hose filled with water was not easily handled, and considerable time was consumed in moving the boat. The hose was accordingly cut in two and the nozzle attached to one-half of it, which length was found sufficient to reach any desired point on the grade. With the shortened hose the nozzle was suspended by a tackle attached to a boom run out from the boat for the purpose. The nozzle could then be directed more easily, and generally required but one man. In moving the boat, the hose was lifted clear of the ground by means of the tackle.

The stream was usually applied from the already graded bank, in a line slightly inclined downwards towards the water's edge, so that, as a bench was carried up the slope, a channel would always be kept open for washing the loosened earth into the river.

Six nozzles were tried, ranging in size from 1½ to 2 3/16 inches. The one which gave the best results was 1¾ inches.

Grading was at first commenced where the mat had already been laid, but it was found after several days' trial that the stream of water and earth flowing down the bank rolled the edge of the mat up and forced it away from shore, making it difficult to attach the high water protection, besides allowing a deposit to accumulate under the mat near shore. The grader was therefore dropped below the mattress-boat and the bank above that point was graded by hand.

The bank as left by the grader was in most cases rough and uneven on account of the frequent occurrence of soft strata near the water's edge, and, in several places, it was necessary to employ hand labor to even it up.

The best speed accomplished in grading was 280 linear feet (2,752 cubic yards) in eight and one-half hours, or at the rate of 33 feet (324 cubic yards) per hour. The average working speed for ten hours was 203 linear feet.

The amount graded was 3,592 linear feet, or in cubic yards, 33,455. The cost per cubic yard was $0.0158, and amount graded per bushel of coal, 26.44 cubic yards.

The high water protection was woven, but made thicker than the low water mat, and no netting was used in its construction. It was weighted with rock at the head of the work and along the ice-line. The amount of brush used per square was 0.43 cord, and the total cost per square, $1.36.

Four thousand three hundred and eighty linear feet of bank was revetted in the manner described above, the cost per foot being $2.77.

In July, 1881, a survey of the river was made from Saint Joseph to Palermo, and in April, 1882, a low water survey was made from Saint Joseph to Geary City.

I have been assisted on the work of the past year by Messrs. W. H. Floyd, jr., and W. Henderson, assistant engineers.

I have the honor, major, to be, very respectfully, your obedient servant,

D. W. CHURCH,
Assistant Engineer.

Maj. CHARLES R. SUTER,
Corps of Engineers, U. S. A.

S 10.

IMPROVEMENT OF MISSOURI RIVER AT BROWNVILLE, NEBRASKA.

During the past season an attempt was made to close Sonora Chute with wire-screen dikes supported on tripods. The supports proved inadequate to resist the pressure of the drift, and the work was destroyed before any material results had been accomplished. The appropriation for the work was so small that nothing else could be attempted.

The improvement of the river in this vicinity is bound to be a costly operation, and can only be successfully undertaken with ample funds and after the river above has been gotten under control, while the requirements of navigation are not pressing. It has, therefore, been decided, with your approval, to defer further work at this point till it is reached by the general improvement.

The work has been in charge of Assistants W. B. Hammond and J. W. Pearl.

The work is situated in the collection district of New Orleans, and the nearest port of delivery is Omaha, Nebr. The nearest fort is at Leavenworth, Kans.

Amount of revenue collected at Omaha, Nebr., during the fiscal year ending June 30, 1882, was $4,525.82.

Money statement.

July 1, 1881, amount available	$8,745 77
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	8,312 39
July 1, 1882, amount available	433 38

REPORT OF MR. J. W. PEARL, ASSISTANT ENGINEER.

BROWNVILLE, NEBR., *June* 30, 1882.

MAJOR: I have the honor to present the following report of operations, under your direction, on the Missouri River, in this vicinity, during the fiscal year ending to-day:

Previous to the period covered by this report, a general project for the improvement of the river from Otoe City to Aspinwall, Nebr., was submitted by your assistant, W. B. Hammond, and approved.

For the execution of the project, an initial point was selected about 7 miles above Brownville, where the river has for many years confined itself to a stable section with high sandstone bluffs for the right and a low sloping shore for the left bank.

The first work in order in the general scheme for improvement was to close Sonora Chute, a channel 500 feet wide, with an average depth of 6 feet at a medium stage of water. It opens from the right bank one-half mile below the initial point selected in the project and carries about one-sixth of the whole volume of the Missouri, returning it at right angles to the main stream about 4 miles below.

The excessive erosion of the left bank, above Brownville, and of the right bank below, was largely attributed to the deflecting action of the water delivered from this chute.

An experimental dike (Dike No. 1), constructed of stiff weeds, was placed across the chute about one-half mile below its entrance, at a total cost of $185.97, during the month of December, 1880. The dike was carried away by the flood of ice in the spring of 1881. Detailed plans and estimates for a pile and wire-screen dike across the entrance to the chute were then submitted and duly approved. The piles, screen, rock, and other material for dike construction were delivered at the site of proposed work during the spring of 1881.

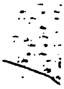
At the beginning of the year, July 1, 1881, and for some time before, everything was in readiness and awaiting the arrival of a pile-sinker which was expected to place the supports for the dike. On the 15th of July instructions were received to proceed at once with the construction of Dike No. 2, using tripods or buoys for supports, as the pile-sinker would not be available.

DIKE NO. 2.

On July 16 the preparation of an improved tripod plant commenced, and on the 20th the first tripod was placed. Starting from the bluff about one-half mile above, a line of tripods was extended down stream on the proposed shore-line until the head of of Sonora Island was passed.

The tripods, 12 in number, were constructed from cottonwood piles 8 inches in diameter at the top, and of lengths adapted to water ranging from 4 to 22 feet in depth. An average of 1¼ yards of rock per tripod was attached to the lower angles of the frames as ballast. In the deepest water the stability of the tripod was increased by attaching a Chinese anchor to the up-stream leg. In light water little ballast was required.

The screen was delivered from the net machine in rolls, and laid from an open barge, the rolls resting on rollers placed at the bottom of the boat. Bailed rock anchors were attached along the ground edge of the net as it was unrolled and dropped. The air



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edge was supported by oil-barrel buoys at intervals of about 15 feet, and tripods at intervals of about 200 feet.

The screen and its method of construction were fully described in report of last year. I will, however, repeat that it was made from No. 12 and No. 14 wire, with equilateral triangular meshes having an altitude of 18 inches, and was provided with a selvage along each edge. Its width was about double the depth of water where placed.

The rock used on the work was obtained from a quarry near at hand, but was very expensive.

The dike, 2,700 feet long, was completed on August 1, 1881.

As *débris* collected on the net the barrel buoys were dragged under water and it was found necessary to support the air edge with struts. Piles weighted with rock at their lower extremities were placed vertically and at intervals of 20 feet along the lower side of the work. The air edge of the net was raised as high as possible and attached to them, and the buoys removed.

As this work progressed the error of using light (No. 12 or 14) wire net and placing it slack in exposed work on a concave shore-line was sufficiently demonstrated. The portion touching bottom was quickly and firmly bedded in the sand and the air edge could only be raised a few inches without tearing the net.

The stage of water being far along in its decline when the dike was placed, the amount of material in transit was insufficient to immediately accomplish the desired result. A low bar was slowly deposited across the entrance to the chute. The waterway at times was reduced to 60 feet, but the screen along the face of the work was continually exposed to raking attack from the heavy drift which wandered in its vicinity with every little rise of the river.

The many breaks made in the netting were promptly and persistently repaired until about November 10, when the care of the work was transferred to me. The formation of a high bar could not be expected after that date and before the river closed. No hopes of holding the screens through a run of ice were entertained and the work was temporarily abandoned.

TOTAL AND UNIT COST OF DIKE NO. 2.

Superintendence	$0 126	$342 99
Making net	101	273 81
Placing supports	146	395 48
Placing nets	090	236 28
Wire cable	012	31 57
Anchors	035	93 92
Repairs	065	174 82
Material:		
Wire	282	763 44
Piles	137	369 80
Rock	080	217 60
Sundries	025	68 54
Cost per linear foot	1 099	2,968 25

On November 19, the first mush ice of the season appeared in the river running very thick. It broke through Dike No. 2 in several places, doing considerable damage. Our barges were at once hauled to a good harbor below the dike and all plant stored in winter quarters. At the close of the month the balance of our funds being reduced to $2,572.31, the force employed was reduced to the bare necessities of existence and care of property.

A mild winter, and a light run of ice, left the vicinity of Dike No. 2 in much better condition after the April rise than was anticipated. All the screen had vanished, but four tripods remained standing. The chute had quite recovered from the past season's water famine and might now be termed open to navigation at all stages. The steamer Wyoming, heavily loaded, passed safely up the chute, May 14, 1882; yet, as the water subsided, the main channel took to the left bank of the river above the work and continued along this bank as far down as Sonora, with a large shore bar on the right bank extending out from Sonora Island. The broad shore bar below Sonora was dropping away and the channel moved on toward Sun Island at a very encouraging rate.

The desired channel changes in this locality were successfully initiated, but the cause was removed, and a reaction was expected.

On May 1 a balance of only $1,097.31, a plant prepared only to place tripods, an abundance of decaying piles and expensive rock, and sufficient wire too small for heavy work, remained from the supply for last season's operations. A project for the reconstruction of Dike No. 2 with the material and funds on hand, using overlapping or "shingled" sections instead of continuous line work, was submitted and approved.

The supply of wire was exhausted, and sufficient net completed on May 8. The tripod plant was then repaired, and on the 11th the placing of tripod supports for screens commenced. Starting about 500 feet below the heading of previous work, the dike was reconstructed in six sections, standing at an angle of about 50 degrees with the current (angling downstream). Each section extended out to the line of the original dike and overlapped the adjacent section about 100 feet.

Thirty tripods, similar to those placed in 1881, were placed in position with peaks as near flood-height as could be obtained. They were ballasted with three-tenths of a yard of rock on each upstream and one-tenth yard on each downstream leg or angle. The peaks of tripods standing in each section were connected by a wire cable of our own manufacture, containing six strands of No. 12 wire.

The net used was similar to that previously described, and had a five-wire cable along the air-edge and a four-wire cable along the ground edge. In launching, the air-edge of the net was connected at every mesh with the cable previously placed along the tripods, and the ground edge anchored with 12 pounds of rock per linear foot.

To prevent scour at the ends of the sections, the screens were extended about 50 feet beyond their limits, and firmly anchored. The work, 2,700 feet long, was completed June 1, 1882.

After the screen was placed, a small force was employed placing struts to support the air edge of the net and the cable at points between the tripods, and for a time all was working well. At points where sections overlapped bars appeared above water-surface, and at other points the deposits were very satisfactory.

As the load accumulated on the net, however, the water fell away below and the work assumed the nature of a dam; breaks in the cable occurred in various places, and were quickly repaired by the workmen constantly employed for that purpose.

Weakness was apparent throughout the length, breadth, and depth of the structure. As the rising water of June came on the invalid became unmanageable, and the caring hands were withdrawn.

TOTAL AND UNIT COST OF DIKE NO. 2 (RECONSTRUCTED).

Superintendence	$0 054	$145 00
Making net	058	156 94
Placing supports	056	153 53
Placing net	018	47 25
Wire cable	005	13 93
Anchors	007	19 60
Repairs	024	64 53
Materials:		
Wire	106	286 60
Piles	129	347 16
Rock	057	154 61
Sundries	007	17 95
Cost per linear foot	0 521 Total..	1,407 09

Piece by piece the net was stripped from the tripods, and as they in turn were exposed to the rising water, a portion of them followed in the wake of their former burden. The upper half of Dike No. 2 (reconstructed) is washed out.

TRIPODS AND TRIPOD PLANT.

For constructing and placing tripods, two 10 by 50 foot barges were placed side by side, connected at upstream end and spread out at lower end so as to form a V-shaped well, over which the tripods were built. A shear provided with the necessary tackle for handling the piles was arranged by connecting two 40-foot spars by an eye-bolt at the top and raising them nearly vertical, with heels resting in rounded sockets placed near the center of each barge and the top staid by guy-lines. For heavy lifts the line leading from the shear-blocks was carried to a "gypsy" windlass placed near the bow of one of the barges. When in position the piles were supported on trip-blocks, which extended over the inner edge of each barge near the stern, and a strong plank laid across the barges toward the bow. By a rope extending from one barge to the other across the lower side of the "well" they could easily be adjusted to any desired angle or any sized tripod. The "tripod" is a frame-work of six piles or poles, so connected that each lies approximately at the diedral angle of a tetrahedron. The three uprights are called "legs" and the horizontals "braces."

The legs were connected by a three-quarter-inch rod passing through each pile and bent over at the ends so as to hold them together at the peak. They were then floated into the well, the shear tackle was connected at the peak and the legs raised and swung into position with each side or down-stream leg resting on a trip-block, and the middle or up-stream leg resting on the cross-plank. The braces and legs were scored to joints and fastened by two 10-inch boat-spikes through each end of each brace. The tripod was completed by attaching the necessary ballast on the lower angles.

By tripping the side legs the down-stream side of tripod takes water and the current draws the middle leg from the cross plank. In this half overturned manner, it strikes bottom, and as the middle leg settles to position the peak walks up into line as desired.

For a "makeshift" machine this is a very good one. Its general adjustability, its cheapness, and the ease with which it or the heaviest tripods can be handled in any water at once commend it. By the addition of a small hoisting engine and some slight changes in minor parts, it would work rapidly and take rank with the first appliances for this class of work.

SURVEYS.

A few detached surveys for the location of important changes in shore lines near Dike No. 2 and Brownville were made in July, August, and September.

But few of the changes by and subsequent to the flood of May, 1881, have been located on the map of this reach. A survey should soon be made from Otoe City to Aspinwall.

Regular soundings on sections at Dike No. 2 were taken until the dike was abandoned in November; the results are not of particular interest.

Slope observations from Otoe City to Brownville were taken in September, and the results were duly submitted.

Ground-water observations have been continued throughout the year.

During the winter a survey of the Nishnabotna River, provided for by special appropriation, was made, and a map and report on the same were submitted from this office.

At Brownville the condition of the river is unimproved. The channel divides below the mouth of Sonora Chute, leaving a large sand bar in the center, which extends down between the ferry landings; the erosion of the left bank above and the right bank below continues. The same, in all probability, will continue as long as driblet appropriations are supplied, and the engineer must look upon an attempt at good work with an eye fearing bankruptcy ere the task is completed.

I am, major, very respectfully, your obedient servant,

J. W. PEARL,
Assistant Engineer.

CHAS. R. SUTER.
Major of Engineers, U. S. A.

S 11.

IMPROVEMENT OF MISSOURI RIVER AT EASTPORT, IOWA, AND NEBRASKA CITY, NEBRASKA.

Work at this point during the past season has been confined to training works, composed of wire screens supported on pile bents, located in Copeland's Bend. These structures gave very excellent and promising results, but lack of funds prevented their receiving sufficient extension or solidity of construction. Owing to the very great difficulty of doing anything with this reach till the river above as far as the Platte is under control, it has been decided to suspend all work at this point, except the revetment of the exposed left bank in Eastport Bend, till the reach can be taken up in the course of the general improvement of the river. The work of revetting this bank will be undertaken this season and carried on under an allotment from the general appropriation for improving Missouri River from its mouth to Sioux City, Iowa.

The work has been under the charge of Assistant A. S. Potter.

This work is situated in the collection district of New Orleans, and the nearest port of delivery is Omaha, Nebr. The nearest fort is at Leavenworth, Kans.

Amount of revenue collected at Omaha, Nebr., during fiscal year ending June 30, 1882, was $4,525.82.

Money statement.

July 1, 1881, amount available	$18,482 04
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	17,655 76
July 1, 1882, amount available	826 28

REPORT OF MR. ARTHUR S. POTTER, ASSISTANT ENGINEER.

NEBRASKA CITY, NEBR., *July* 1, 1882.

MAJOR: I have the honor to submit the following report on the work under my charge at Nebraska City and vicinity for the year ending June 30, 1882.

The advancement of the work the past year, as in previous ones, has been greatly retarded by insufficient funds to carry out work begun and contemplated. An attempt has been made, however, to accomplish something.

The details of methods used, appliances employed, and results obtained are illustrated by drawings. A list and description of these, also a complete financial statement covering expenditures for the year, accompany the main report.

Work was in progress at the time of submitting the last report, which covered everything to July 1, 1881.

BUOY DIKE.

From July 1 to 9, 1881, 2,010 linear feet of buoy dike, with netting 40 feet wide, was placed opposite Neligh's. Its location is indicated by the broken line A E on the accompanying map of the reach. The apparatus used and the methods of placing, anchoring, mooring, and buoying the screen were fully described and illustrated in report for year ending June 30, 1881. The results of the dike were shown by tracings of hydrographical surveys made behind it on established ranges.

QUARRY.

The quarry in the vicinity of Neligh's was continued in operation until July 31, in order to get a stock of rock on hand that would last until the available balance was exhausted. The total amount of rock taken out during the month of July was 219.45 tons, at a cost of $1.1215 per ton.

The supply of rock on this reach is unlimited. It crops out in abundance almost the entire distance from Rock Bluffs to Jones's Point, again from Wyoming to Neligh's from △ 354 to △ 24, and a distance of 2 miles along the bluff below the city.

TESTING PILE-SINKER.

During the month of July, 1881, considerable time was devoted to testing the pile-sinker completed on this work July 10. The entire apparatus was illustrated on Plate V of report for last season.

The essential portions to be tested were the turn-table and guides and the machinery connected therewith. About $225 was expended in making the tests. Everything worked hard, and consequently slow. Bearings were rough and labor inexperienced, and the piles we had in stock seemed too crooked to work smoothly in the apparatus. The greatest speed made was twenty piles in ten hours. It was thought best therefore to abandon the turn-table and guides until the future should show the necessity for their use.

The apparatus as changed and used this spring is shown in Figures IV, V, VI, and VII, and will be described later.

WIRE NET.

In July there was manufactured stock net as follows: 6,120 linear feet, 40 feet wide triangular mesh of 1¼ square foot area, and of Nos. 13, 14, and 15 annealed steel wire. The total expense of manufacture, including wire, was 19.2 cents per square of 100 square feet.

Prior to July 1 there was manufactured 6,298 linear feet, as reported upon in report of last year, making a total for the season of 12,397 linear feet, varying in width from 25 to 50 feet. Of the whole amount there was used in the construction and repairs of buoy-dike, prior to July 9, 4,260 feet, leaving in stock for future use 8,137 linear feet.

All our net was constructed with triangular mesh of 1¼ square foot area, and experience to present date has not suggested a change in size. I think, however, if a rectangular mesh could be devised in which the wires would be continuous each way it would be an improvement on the one in use here.

PILES.

During the month of November, 1881, 25,918 linear feet of piles were peeled and skidded to prevent decay. The expense connected with this work was only twenty-three hundredths cent per linear foot. It is thought that on account of their smooth surface, much more than this amount would be saved while sinking, and that in all cases it would pay well to peel them.

BAR DIKE.

During the season 2,800 feet of dike, named as above, were placed along the bar opposite Neligh's as indicated by the blue line between A and B.

This construction was mainly an experiment and put in to see what it would accomplish. The support as used at first is shown in Fig. I. These were placed along the bar in a straight line, 20 feet apart, their tops all at the level of an 11-foot stage on the United States gauge, and connected by a cable of nine No. 14 wires.

The upper edge of a 25-foot net was secured to the cable, and to the lower edge anchor rocks were attached 4 feet apart. The net was stretched as tightly as possible both in width and length. When the strain due to ice, drift, &c., came upon it the anchors moved down in the direction of the current, leaving the net slack and many of the supports closed up, as it were.

After the ice action was over the members and ties D, E, F, G, H, Fig. II, were added to the supports. This improved form proved efficient, but not a desirable construction, there being considerable more material used than necessary to accomplish the purpose.

It is thought that any bar construction of this character should be very strong, the supports all made of three poles, or short piles if need be, not less than 6 inches top peeled diameter, sunk in the sand at least one and one-half times as deep as the height above the bar. The tops of the tripods should be firmly secured. The tripods should not be more than 20 feet apart, and should be connected by about a three-fourths-inch cable, under considerable strain. The width of the attached net should not be less than four times the height of the tripod above the bar. A construction of this kind, if continuous, should not have a greater angle with the direction of the current than 40 degrees.

PILE DIKE.

From April 1 to May 6, 5,200 linear feet of pile dike was placed along the location indicated by the line B C D on the map of reach.

Very few piles were used on this dike less than 30 feet in length, and those only in water not exceeding 4 feet in depth. Piles 30 feet long were used in water not exceeding 8 feet in depth, and 35 feet long in all other cases. The deepest water sunk in was 12 feet.

The distance between bents in all cases was 24 feet, making in all two hundred and sixteen bents, of which there are forty triple bents, one hundred and seventeen A or two-pile bents, and fifty-nine single-pile bents, sunk in water from 4 to 12 feet in depth and sand from 10 to 19 feet.

Net, of No. 13 wire, was placed on this, varying in width from 35 to 50 feet, anchored at the lower edge with anchor rock, each weighing 150 pounds, attached 4 feet apart. The piles in the A bents were sunk on an incline of about 15° with the vertical, or 30° with each other. A cable consisting of twenty-one strands of No. 13 annealed steel wire was, while under strain, firmly secured to the top of each bent, and to this the net was attached. The total cost of this construction was 57.8 cents per linear foot.

The effect of the dike in point of filling was all that could be desired. In locations where the piles were sunk in 12 feet of water in a few days the deposit had accumulated to within 18 inches of the surface. In fact, along the whole length of the work, except in a few places where small chutes had formed, the water was very shoal and the bar raised gradually as the water raised. If at any time the water fell 1 foot the bar became visible almost the entire length. In many places, immediately beneath the piles along the line of work the water would often measure 10 feet in depth, while from 10 to 20 feet behind the dike the depth would have decreased to 1 foot.

This style of a dike as a bar producer is an admirable construction, but it only has the requisite strength for medium stages of water on this reach, or flood stages on portions of the river where the slope does not exceed 8 inches to the mile.

Our experience here would indicate that all pile dike along main lines should consist its entire length of three-pile bents, each pile sunk as deeply as possible into the sand, and with a top diameter of not less than 8 inches. In all cases where the line of work passes through water of a greater depth than 12 feet the bottom should first be raised by a wide net-buoy construction until the desired depth is attained. After the deposit has been produced and the filled net lays like a mattress on its deposit, pile construction should be continued, in which case the net will assist in the prevention of scour around the foot of the piles.

Main lines, however strong, should in all cases be re-enforced by sufficient cross-dikes placed parallel to each other and at an angle not greater than 40° with the direction of the current. The ends of each cross-dike should terminate in the main shore line and the main line of dike.

REPAIRS OF DIKES.

Of the bar dike previously described, 1,480 feet has been covered a second time with net. It was again broken during the April flood, and repaired a second time by 225 feet of buoy dike. This was replaced in due time by pile construction.

BUOYS.

In July, 1881, seventy paper buoys were made for use on work the following season. The form and method of construction were fully reported upon in annual report of last year. The individual cost of these buoys was $59.71.

Considerable study has been put upon this subject, as it was thought that the production of a buoy which would support a weight of from 150 to 400 pounds, made of such material as would render it durable when exposed simultaneously to both sun and water, and the cost of which would be a minimum for the work done, was obviously desirable. The results of our investigation show that for price and efficiency of work nothing compares with second-hand oil barrels. We have found that almost an unlimited number can be delivered at Nebraska City for 90 cents apiece.

MATTRESS.

No mattress work has been done during the past year except experimental or model.

LOW-WATER SURVEY.

A tracing of a map, scale 2,000 feet to 1 inch, accompanies this report. The map from which it was taken was produced from notes of a survey made during October and November, from Rock Bluffs to the line between Iowa and Missouri, a distance of about 35 miles. It will be noticed that many bench-lines have been run the past year in the vicinity of "Bartlet," "Keg Creek Slough," "Weeping Water Bottom," between "Base-line Road" and "Valley Section," and in "Wilhelm Bottom." The necessary physical observations connected therewith have not yet been made with sufficient care to warrant the advancement of a theory as to the probable location of the river bed in past years. Many other benches or physical features are awaiting location as soon as the expenditure of the necessary funds is warrantable.

HYDROGRAPHICAL SURVEYS.

Cross-sections have been taken on twelve ranges, located between Wyoming and the city, six times during the past year. The notes are mostly platted and the maps on file in this office for reference.

GROUND WATER.

On March 20, 1881, arrangements were made with eight parties residing at nearly regular intervals from each other along the "Base-line Road" on the Iowa bottom to take readings in their wells each morning before any water had been taken from them. The method of taking the readings was fully described in last year's report. In the case of B. Harris, he changed his place of residence at the beginning of high-water, after which the well was found to be filled with silt. Readings taken by him prior to flood were worthless, therefore his record is omitted on the sheet entirely.

The readings in two wells only were taken continuously from March 22 to December 1, 1881. The others on account of high-water and unknown causes are somewhat fragmentary. The readings have all been platted up, however, in each case, compared with the city gauge at the same zero, and a tracing of the same forwarded for the information they contain.

It will be noticed that nearly all through the season the water in well No. 2 was higher than the river. In all other cases it is lower, except during May and June and October and November, which were the rainy months of last year. It is obvious, therefore, that any theory regarding the rapidity of seepage of river water through the bottom lands cannot be intelligently based on these profiles, as the rain-water, an unknown factor, ought to be taken into consideration.

In order to render a set of ground-water profiles valuable, wells should be driven to a depth of at least 35 feet, or below the immediate effect of surface drainage. In the casing should be placed a self-registering apparatus, covered securely at the top to prevent rain influence.

DISCHARGE OBSERVATIONS.

In April there were located at the mouth of Squaw Creek three ranges, 200 feet apart. These are shown in their real position on the map of the reach accompanying

is report. Since May 1, discharge measurements have been taken as frequently as ind and rain would permit. Only a few of these have been platted, and therefore ill be forwarded later as addenda to this report.

I desire to acknowledge the valuable services of my two assistants, E. L. Cooley and . F. Crow. They have contributed very largely to the advancement of the work ere during the past year.

Very respectfully, your obedient servant,

ARTHUR S. POTTER,
Assistant Engineer.

Maj. CHAS. R. SUTER,
Corps of Engineers, U. S. A.

S 12.

IMPROVEMENT OF MISSOURI RIVER AT PLATTSMOUTH, NEBRASKA.

Work at this point has been confined to the construction of training likes composed of wire netting supported on tripods, the object being o train the river in front of Plattsmouth, and to improve the approach o the railroad bridge at that point. Owing to the small size of the appropriation but little could be done, and as it is evident that no work can e attempted here with any prospect of success until the river is held etween Omaha and the Platte, it has been decided to defer further work t this point till it is reached in the general improvement of the river.

The work has been in charge of Assistant W. H. McKnew.

The work is in the collection district of New Orleans, and the nearest port of delivery s Omaha, Nebr. The nearest fort is at Leavenworth, Kans.

Amount of revenue collected at Omaha, Nebr., during fiscal year ending June 30, 1882, was $4,525.82.

Money statement.

July 1, 1881, amount available	$15,416 15
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	13,954 96
July 1, 1882, amount available	1,461 19

REPORT OF MR. W. H. M'KNEW, ASSISTANT ENGINEER.

PLATTSMOUTH, NEBR., *July* 1, 1882.

MAJOR: I have the honor to submit the following report of operations on the Missouri River at Plattsmouth, Nebr., for fiscal year ending June 30, 1882:

Active operations in the field were inaugurated at the beginning of the present fiscal year and confined solely to improvements in Plattsmouth Bend, with the view of rectifying the channel and causing it to pass the Burlington and Missouri River Railroad bridge in a direction more nearly normal to its axis. The existing regimen at flood stage impedes the passage of steamers very seriously, both through the bridge and around the point about 2,000 feet above. At extreme low stage barge transportation is rendered extremely hazardous by the peculiar configuration of shore line at this point.

The serious drawbacks encountered by steamers passing through the bridge at flood stage can be justly attributed, in part at least, to the excessive length of the railroad dike, located on the Iowa side, immediately above the present bridge site. It confines the channel to a width not exceeding 720 feet; consequently, the water as it comes from the basin above is piled up with an excessive slope after passing the point of the dike.

The initial and terminal points of the main longitudinal dike constructed are shown at A and C. D, E, and F are both cross dikes and G a combination of dike and sand fence in the chute behind Willow Island. A shows also the location of a woven willow mattress, of limited dimensions, placed there to protect the head of the island against erosion. In all, 3,882 linear feet tripod dike; 1,700 linear feet pile dike; 725 linear feet combined dike and sand fence, and 6,125 square feet of woven willow mattress were constructed.

It was the original design to extend the dike several thousand feet below C, but, as funds were exhausted, we were compelled to discontinue operations, leaving things incomplete.

The results anticipated, prior to placing the work, can at the best be only partially realized, as the dike does not extend far enough to give the desired direction to the current through the bend below.

In regard to results in the immediate vicinity of the tow-head, near upper end of dike, they can only be looked for to a moderate degree each season, as the character of the Platte River differs materially from the Missouri in the amount and nature of the sediment carried in suspension. However, that portion of the work is comparatively safe from the evil effects of the ice, and will doubtless remain several seasons without the need of many repairs.

In my last report I referred to the change of regimen in the Missouri above this point, its sudden yet desirable transition from Bellevue Chute to its former course in old Saint Mary's Bend. This change at the time was very desirable, and would have proved a benefit to the regimen both above and below had the funds on hand early last fall been adequate to protect the bank against erosion.

The lower portion of the bend has since suffered violent erosion, rendering it impossible to institute improvements without channel rectification.

PHYSICAL DATA.

The collection of physical data has extended over the entire year. Late in the fall a complete low-water survey was made from Bellevue to Rock Bluffs, including the location of both shore lines, sand-bars, islands, soundings on right sections, and slope observations.

In connection with the survey one complete cross-section of the valley was made, beginning immediately below the Burlington and Missouri River Railroad Bridge, thence due east to the bluff along section-line road, a distance of 7 miles. All topographical features were noted, as also the data for an accurate profile.

The detached surveys which have been made at various times throughout the year have all been platted and the maps are on file in this office. A survey of the Platte River has been extended as far up as the Oreapolis pile bridge, including the location of shore lines, islands, and sand bars. Slope has also been observed, and soundings recorded on ranges, generally diagonals.

Observations on *wells* in this immediate vicinity have been regularly observed for the past year, with a view of determining the amount and rate of variation in ground water at different seasons and at different distances from the river. The observations have all been carefully platted and compared with the river profile, but are not submitted with this report, as I consider them incomplete.

Soundings to bed-rock have been made on the neck of land bounded by the Platte River on the south and the Missouri on the east. The location of the respective borings, together with the explanatory notes, may be found on the accompanying map. Samples were taken at different depths, showing the character of the various strata below the subsoil to range between very fine sand and coarse gravel. The apparatus used would not admit of greater penetration than 83 feet.

Platte River has been gauged in the immediate vicinity of Oreapolis bridge at three different stages, respectively 5, 6, and 7 feet on the water gauge. A plat of the same corresponding with these observations has been platted and submitted herewith in connection with the gauge profile. The water gauge referred to above is located on piling at the present site of Oreapolis bridge. It was set August 8, 1881, at an arbitrary reading of 3 feet.

A careful study has been made of Plattsmouth Bend this spring, in conjunction with the improvements. Eight permanent ranges and sixteen partial sections have been regularly observed.

The ranges and part sections are numbered consecutively as shown on the map and accompanying sheets. By a comparison of both, following the sheet from left to right, the changes due to the dike can be readily noted. All readings were reduced to a common gauge before platting.

PILE SINKING.

Our arrangement of plant adopted this spring for pile sinking of a light character is similar to that used at Saint Charles, Mo., during last season.

Two barges, respectively 40 and 60 feet long, were lashed in the form of an L; the former equipped with hand force-pump and a platform, provided with a T rest acting

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s a guide to the piling in its descent; the latter carrying a derrick for handling piling nd a capstan for manipulating the lines when shifting position from bent to bent.

The plant described proved totally inadequate for rapid and effective work. Howver, as the funds available would not justify the necessary steam equipment, we were bliged to prosecute the work at a disadvantage the entire season.

Eight men were engaged in operating the hand force-pump at an average speed of fty strokes per minute, corresponding to a discharge of seventy gallons. Three were equired at the hand winch when bringing head-line strain on piling, and two at the ame time in keeping the pile *alive*. A much greater force was required for ineffectve work than could possibly have been needed in connection with steam apparatus.

Attached to the pump was a 50-foot rubber hose connecting with a 1¼ inch gas-pipe, he upper end shaped in the form of a goose-neck, the lower tapered to a seven-eighthnch nozzle.

Piling used in the construction of the dike were on an average of 10-inch butt diamter, ranging from 22 to 35 feet in length.

The method of mooring and shifting the position of the L arrangement of barges has een frequently described. When the barges are in position, the first step towards ile sinking is to draw the pile on board and prepare the butt end—as illustrated in ccompanying drawing; then pipe is attached, the nozzle projecting at least 2 inches elow the lower face.

The derrick line is attached near the middle and the pile is then hoisted and swung nto position. The top is brought inside the T rest by the head-line and the foot set y aid of the heel-line. The pump is started at once, to avoid choking the pipe with and and endangering the hose.

Usually we were able to sink the pile to its lowest limit without resorting to headine strain, two men being engaged in keeping it *alive*. The style of bents adopted are ermed the A and tripod, with an inclosed angle varying between 30° and and 40°. 'he piling are secured at their intersection by drift bolts and occasionally wound with eavy wire.

Preparatory to placing netting a three-eighth-inch wire rope was stretched from peak o peak, and securely fastened to each tripod bent. Netting was placed as shown in he view accompanying this report.

It has been necessary to renew the netting on the pile dike, the drift and excessive ccumulation of fiber destroying it completely. Notwithstanding the numerous breaks, he results have been very marked. Within a week after placing the netting a fill as noted at the lower end of main dike of 10 feet, and extending to the lower crossike, 400 feet below.

The construction of the tripod dikes is very simple, requiring only a limited amount f apparatus and but few barges for rapid and effective work. In placing dike of this haracter, barges were generally held in position by the frames already set. Large, eavy tripods were manufactured on the barge accompanying the one equipped with he derrick, as shown in sketch, then anchored with rock and swung into position by errick. It was guided in its descent by heel-lines. The lighter frames, not exceedg 8 or 10 feet in height, were in some cases manufactured on the bank and loaded on he barge ready for placing. The amount of rock needed for anchorage depends on ize of frame and velocity of current, varying between 1,200 and 2,500 pounds. The cable nd netting were placed in the same way as on pile dike already described. The triod dike is located in an easy current, with a depth of water ranging from 6 to 12 feet. 'hus far the netting has remained uninjured, the drift and fiber not gathering to the xtent as before stated in reference to the pile dike.

The fill back of netting will not compare favorably with the results at lower end of ork, yet it is doing well and will finally accomplish the desired results.

The sand fence is a combination of willows and wire, constructed as follows: Vertial posts are set 10 feet apart and supported on either side by braces extending to the p. Horizontal wires are placed on the top and side of these frames, and willows inrwoven as shown in sketch. This construction was designed for the chute back of he island, with a view to building up a wind ridge, thereby aiding the work above. 'he woven willow mattress work is the same as that described in previous reports on nprovements in this river.

Before closing I wish to acknowledge the able assistance of Mr. M. A. McKnew on onstruction; Mr. C. P. Ruple on surveys the earlier part of season; also Mr. A. C. astman in the office as clerk and draughtsman.

I am, major, very respectfully, your obedient servant,

W. H. McKNEW,
Assistant Engineer.

Maj. CHARLES R. SUTER,
Corps of Engineers, U. S. A.

S 13.

IMPROVEMENT OF MISSOURI RIVER AT COUNCIL BLUFFS, IOWA, AND OMAHA, NEBRASKA.

During the past season the damages done to the Omaha revetmen were thoroughly repaired, and a system of training works was constructed in the neighborhood of Florence, Nebr., to initiate the regulation of the channel through this important reach. The work done has been successful, and will be carried on during the present season by a allotment from the general fund for improving Missouri River from it mouth to Sioux City, Iowa.

The work has been in charge of Assistant C. S. Pease.

This work is situated in the collection district of New Orleans, and the nearest po of delivery is Omaha, Nebr. The nearest fort is Leavenworth, Kans.

Amount of revenue collected at Omaha, Nebr., during fiscal year ending June 3 1882, was $4,525.82.

Money statement.

July 1, 1881, amount available	$37,624 3
Amount received, sales of fuel to officers	39 3
	37,663 75
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	28,099 8
July 1, 1882, amount available	9,563 95

REPORT OF MR. CHARLES S. PEASE, ASSISTANT ENGINEER.

COUNCIL BLUFFS, IOWA, *July* 1, 1882.

MAJOR: I have the honor to submit the following report of operations during the fiscal year ending June 30, 1882, in the vicinity of Council Bluffs, Iowa, and Omaha, Nebr. By a comparison of the maps of the Florence-Bellevue reach made from surveys of February and of November, 1881, it will be seen that little change has taken place during the fiscal year except at Steamboat Bend. It was extremely unfortunate that the cut-off of April, 1881, occurred in this locality, because an almost ideal piece of river was disfigured and nearly 5 miles of course lost; and, moreover, this cut-off was the third in three years between Omaha and Plattsmouth; it only made a bad matter worse. The previous cut-off had demoralized the slope and course of the river, but with the last event we have between Bellevue bend and Plattsmouth about the most unsettled regimen imaginable.

In the fifteen months following the cut-off the river has developed an elongation of 1¾ miles, by a heavy erosion of the left bank opposite the narrowest part of the old neck. Owing, fortunately, to the bluff contact immediately above Bellevue an increase of slope without material change of current direction is the only observed effect of this cut-off upon the lower river.

This cut-off was caused in the same manner as that at Vermillion, by surface scour rather than by bank erosion. Had it been known that the spring flood of 1881 would be so great, these events might probably have been prevented by a levee along the middle of the neck. The floods, however, being so unexpected at the time such work could have been done, any work of this character was not indicated, and if suggested would have seemed unwarrantable.

The Bellevue cut-off might, possibly, have been closed up and the river restored t its proper channel if taken in hand immediately after the event, but the uncertain of the success of such a heroic measure and the urgency of more important w above combined to limit the scope of operations to the upper part of the reach. old bed of the river in Steamboat bend has since become so sand choked that a project for its reclamation would be almost chimerical.

In consequence of the shifting, last year, of the large bar in the first bend below the Omaha Bridge, the current direction through the bridge has been improved about 70°, with also a slight concentration of flow toward the right bank.

The head of the Iowa shore bar, opposite Omaha, has cut away to a considerable rtent, involving an advance of the shore line on the Nebraska side and an increase f the radius of curvature of Indian Bend. Both these features are favorable to the alization of results of work projected for the rectification of channel near the Union acific Railway Bridge.

Besides the changes caused by training works constructed this year, reported upon ereafter, no particular change has taken place in the reach above Omaha.

OPERATIONS DURING FISCAL YEAR.

REVETMENT.

Repairs of the Omaha revetment.—The high-water protection of the lower brush re-tment of the Omaha front having been somewhat damaged by the spring floods, pairs were made in August, September, and October; 4,867 square yards of continu-s woven willow-work protecting 730 linear feet of bank, and about 60 feet wide, was mply built as in last season by weaving upon the deck of a 60-foot scow set across e current and launching 10 feet at each fleet. The brush cut and tied in 10-inch ndles, was hauled by wagon from Cut-off Lake and boated by sail barge from the icinity of Iowa Lake. Rock for ballasting was obtained from Green's quarry and ated to the work.

The old sectional mattresses placed in 1878 were found intact, and the new work as so placed as to completely cover the bank and lap the old work about 10 feet. he submerged as well as the bank edge was provided with a stout selvage and the hole made to fit the bank closely. The thickness of the mat averaged about 8 inches, d, being made of three-fourths inch selected willows, was very tough and presented fine appearance when completed. All of the flap was ballasted on bottom in the ual manner by dropping the rock upon the mat from a stone barge, working down ith the current.

The following is a statement of cost of the above repairs with distribution of labor d material:

LABOR.

rading bank	$223 32 or	4⅝ cents per square yard.
itting brush	294 70 or	6 cents per square yard.
ating brush	132 81 or	2⅝ cents per square yard.
auling brush	119 40 or	2½ cents per square yard.
'eaving mat	570 58 or	12⅛ cents per square yard.
auling material	92 95 or	2 cents per square yard.
ating rock	61 20 or	1¼ cents per square yard.
ichoring mat	37 75 or	¾ cent per square yard.
wing barges	34 85 or	¾ cent per square yard.
eneral work	176 03 or	3⅝ cents per square yard.
attress anchors	30 05 or	⅝ cent per square yard.
'atching	120 75 or	2½ cents per square yard.

MATERIAL.

ush, rock, and wire	$186 82 or	4 cents per square yard.
Total cost		43 cents per square yard.

Wire screen revetment at Willow Island Chute.—After the Willow Island Chute was sed last summer, an experiment in wire revetment was made at that locality. A by 60 foot barge was laid alongside the bank and the wire-net machine placed upon e bow. As the boat was dropped down, a screen 40 feet wide, made from No. 12 wire th 18-inch hexagonal mesh, was discharged from a pair of simple ways. The sub-rged edge was loaded with 20 pounds of rock per linear foot, and the bank edge stened to upright posts sunk in the bank. The screen was supported, where the nk was very bluff, by a few poles wired to the posts. Some little grading of bank s necessary at a few points; 1,150 linear feet of bank was protected in this man-r.

Before the revetment went on, the bank of light sand deposited by the floods only ew weeks before, was cutting seriously. The erosion ceased immediately after the nk was covered by the screen, it having collected a considerable mass of fibrous tter. For a cheap and quickly built revetment for a bank not exposed to severe rrent, I believe that a well-made and well-placed screen of heavy wire will prove good temporary protection. It will last for one year at least, until some heavier rk can be substituted, or the currents have changed above and the danger of ero-n is past.

The following is a statement of cost, with distribution of labor and material in the ove work.

LABOR.

Cutting poles	$26 28	or 2¼ cents per linear fe
Screen	79 76	or 7 cents per linear fo
Anchorage	1 88	or ⅙ cent per linear f
Grading bank	16 92	or 1½ cents per linear f
Hauling material	24 00	or 2 cents per linear f
General work	63 41	or 5½ cents per linear f

MATERIAL:

Wire	$57 50	or 5 cents per linear f
Total cost		23½ cents per linear f

SCREEN DIKES.

With tripod supports.—Three hundred linear feet of screen dike with tripod pole su- ports were placed near Florence in July, and 400 linear feet near Willow Island Ch The methods of construction were precisely the same as for the earlier portion these works, reported upon in the fiscal year 1881. In consequence of the low an falling stage and the light character of the work, no important results obtained.

The following is a statement of the cost of above work:

LABOR.

Florence tripod dike, 1881:

Supports	$104 26	or 34¾ cents per linear fe
Screen	62 11	or 20¾ cents per linear fe
Anchorage	18 41	or 6¼ cents per linear f
General work	37 26	or 12½ cents per linear fe
Hauling material	30 25	or 10¼ cents per linear fe

MATERIAL.

Wire	$8 50	or 2¾ cents per linear fe
Total cost		86 cents per linear fe

LABOR.

Deyo Dike, 1881:

Supports	$89 00	or 22¼ cents per linear fe
Screen	51 61	or 13 cents per linear fe
Anchorage	36 88	or 9¼ cents per linear fe
General work	89 36	or 22½ cents per linear fe
Hauling material	46 50	or 11⅝ cents per linear fe

MATERIAL.

Wire	$10 25	or 2½ cents per linear fe
Total cost		80¾ cents per linear fe

With pile supports.—As the results obtained through the tripod work of 1881 we meager, both on account of the low and falling stage of water and the inadequacy o the supports, it was decided to construct the screen dikes proposed for the curre season with pile supports. The past spring has been one exceptionally favorable the inception of operations. The winter was comparatively mild, and the sprin opened early with a low river velocity and stage; so that a reasonable amount of wo was practicable before the June rise, the April rise being inconsiderable in amou and of short duration. Some annoyance was experienced in preparing a plant, her inafter described, but on the 15th of April work was begun and continued activel until about June 15, when all the work advisable was completed and a limited cr retained to execute minor repairs and re-enforce existing works.

The project for the spring season's operations contemplated such an amount an character of work as would train the flow below Florence towards the right ban by building out the left opposite, and insure a permanent channel location in Floren Pocket. This project, while being in accordance with the general plan of regula tion as to slope, width, and depth, involves as well provision for better channel dire tion at the Union Pacific Railway Bridge, and along the harbor front of Omaha, as ex plained in previous reports. The Florence Bend may be regarded as nearly permanen on account of the local bluff contact and the conditions of the preceding bend. Flo ence Bend, while not meeting exact requirements, is always navigable; so, start from this bend as a base, the above project contemplates continuing a proper chann way width by suitable training works throughout the reach. The work of the current season, as to general scope and detail, has been as follows: The results to be accomplished seemed to indicate Saw-Mill Point as the beginning of the proposed training work, and accordingly screen spur dikes, aggregating 1,650 linear feet, were built in this locality. They were inclined slightly down stream while at an angle of nearly 90 degrees with the current. Before this, however, a considerable number of shore tripod dikes, amounting in all to 3,700 linear feet, were built out from the high shore to the bar edge. The pile spurs above were in continuation of this lighter work. The bents were set in parallel vertical planes 15 feet apart, with an intersection angle of 45 degrees, and so that a vertical line through the intersection would bisect the angle. The bent was completed after pile setting by a heavy wrap of No. 12 wire around the intersection, and a five-sixteenths inch drift bolt through each pile at the same point; a hand-made wire cable, one-half inch diameter, was then stretched along the bents and fastened to each. The screen boat followed the pile sinker and placed the screen, first attaching the air edge of the net to the cable and ballasting by wired rock the ground edge, the bottom of the screen being placed as far as possible up stream from the foot of the bent.

After the last spur was completed the pile sinker was moored on the proposed shore-range and the work continued on this line in the same manner. After a length of 500 feet of profile work had been constructed, a 3-foot rise in the river occurred and carried away nearly all the spur work.

This first work was rather experimental, as our crew was green, and the capacity of the plant a matter of doubt. We had no engine until nearly all of this spur-work was completed, and the necessary power in head-line strain was wanting. A penetration, then, believed sufficient, was obtained, but undoubtedly not sufficient as viewed in the light of present experience. A large raft of piles broke away and went through the dikes on the same night, and to it the disaster may probably be attributed. The lower profile work was stopped at once and the plant moved up to a point on the proposed shore line near the end of the first spur, and a profile dike along the range begun. This work, in A bents, was continued through May and half of June, and down to a point opposite the head of the Florence Pocket sand-bar. The whole was cabled, drift-bolted, wire-strapped, and provided with screen by the middle of June.

In the mean time, over 1,000 linear feet of A bent spurs under shelter of the profile work were built by a small plant, consisting of a 12 by 60 foot scow provided with derrick, capstan, and a deck-pump which discharged one gallon per stroke through 1-inch hose and a five-eighths-inch nozzle. The small pile-sinker was only a makeshift and intended to build light spur-work under shelter of the profile dike While in operation it did very satisfactory work. The method of operating it produced the same character of work with the other outfit, although smaller piles were used. The only apparatus was a derrick for hoisting the pile, the pump, and nozzle for the jet, and a capstan actuating the hoisting line and heel rope.

As soon as the large outfit completed the profile work, the small scow was laid up and a few short spurs built by the other across chutes and minor "draws." Total length of pile-screen dikes constructed in 1882, 7,218 linear feet. The method of operating the pile-sinker this year has been as follows: (see also drawings herewith showing detailed sketches of the plant and application of jet to pile): The piles are delivered in rafts of six to ten by a skiff dropping down on the outside of the dike. This raft is snubbed at the stern of the pile-sinker, with the pile tops upstream toward the barge. A small lighter, as shown on the accompanying drawing, is made fast astern and always kept there for use.

When a pile is wanted, one is selected from the raft, and hauled alongside the lighter by two men standing in the lighter. After the hose is pulled from a sunken pile, it is passed astern, and with play-pipe and a stout marline is laid on the pile lengthwise, with the nozzle flush with the butt end. A staple of one-fourth or five-sixthteenths-inch iron is driven over the nozzle-tip into the pile, including also a marline which is 30 feet long and attached back on the coupling 4 feet from nozzle-tip. Another staple is driven over the nozzle just below the coupling, but not over the returned marline. While this is being done, a line provided with 6 feet of chain and a grab-hook, and which runs from the drum of the hoisting engine through a deck-block at the heel of the boom, thence through a gin-block at the head of the boom, is attached to the top of the pile by two turns and a grab. At the same time, another line, running from the winch-head through a deck snatch-block astern, and thence back along the inside gunwale to another deck-block, thence astern again, is made fast to the pile about 5 feet from its butt end. Now, all is ready to hoist. A deck-hand holds fast the marline so that the nozzle, lying rather loosely in its staples, shall not pull out toward the top of the pile. The coupling between hose and play-pipe resting on the upper staples restrains it from moving out in the other direction. The engineer goes ahead on his engine with drum and winch and, while the top is being drawn up to the boom-head, the butt of the pile is coming around against the current under the action of the heel-rope to the winch. The top is in position first; the engine-drum is then thrown out of gear and braked, while the winch runs on until the pile is brought around to a vertical position by the heel rope. Engine is then stopped; boom is so guyed that the pile hangs directly in front of the rack; the lower clutch is thrown around the pile; rack is run over with the pilot-wheel; the upper clutch set; heel rope cast loose: proper inclination given with rack; brake loosened on drum, and pile shoots through the clutches to bottom at the same inclination. The head-line is adjusted by a ring to the chain-hitch already on pile, and is passed through block on platform in front of rack, through snatch-block astern, and thence to winch-head. Pump is started up with rack in motion shaking up the pile, the head-line pulling away steadily. When the pile refuses to go further or is deep enough, the deck-hand lets go the marline and two men pull out the hose, the pump being stopped when it is seen that the hose is coming up all right. The clutches are swung away and the pile stands free. The off pile being set first, the engine goes ahead on the spar-line, and swings the barge out to set the other pile, while new attachments are being made. The next pile completing the bent is set in the same manner, except that the inclination is reversed, and the top pointed away from the barge. No. 14 wire is wound around the intersection of the two piles to the diameter of three-fourths inch, and tightened up by a steel twister and a drift-bolt put through. The stern and breast lines are slackened, and the current carries the outfit along to the next position. At every alternate bent a turn around the "near" pile is made with the cable. The cable is tightened up with the engine when necessary.

I believe it would be advisable to give the lower clutch a sliding adjustment of 2 or 3 feet, in order to eliminate the longer time required in swinging out to set the "near" pile. Another fault is that the barge is too small; there is not deck-room enough for convenient operation, and as the barge is only 60 feet long, the center of pressure of the current force is below the supports. For this reason the current is continually tending to throw the outfit inshore. As shown on the accompanying drawing, a spar has been placed at the bow, and by hauling away on the line passing around it, the bow is thrown into the dike between two bents, thus swinging around on the last finished bent into position for work. In order to set bents well, the boat should be 20 or 30 feet longer.

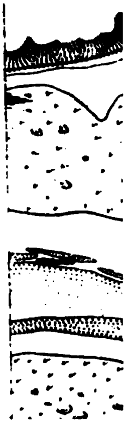
The bents were set about 20 feet apart throughout the profile work, and the more exposed portions supplied with a heavy three-forths-inch wire cable in addition to the hand-made one.

In order to prevent any undue accumulation of strain, tie-cables connecting the top of one bent with the bottom of the preceding bent, were employed at intervals of 100 feet. The screen was made upon the machine shown in the accompanying drawings, and consisted principally of No. 12 wire. It was made from 35 to 45 feet wide, depending upon depth of water, with meshes from 14 to 24 inches square. It was placed in the usual manner, and completed soon after the pile-sinker had finished with the supports. Very little screen was visible on the 23d instant, as from the 10th to that time the water rose 7½ feet, and a considerable amount of heavy drift running along the face of the dike tore off the net almost entirely. The dike as it is, however, is doing fine work, and if it weathers the June rise, I have no doubt that the desired results will be realized. The accompanying set of drawings of comparative cross-section will illustrate better than words the effect of the work.

NOTES AND OBSERVATIONS ON PILE-SINKING.

Special and general.—All piles used at Omaha and Council Bluffs during 1882 were cottonwood. These were chosen because it was believed they would meet all requirements, and because Norway pine was almost twice as expensive. Cost, 10 cents per linear foot delivered in rafts of 10 to 100 at points agreed upon. Length of piles, 18 to 32 feet, principally 30 feet. Diameter, 6 inches tip and 8 inches butt, to 10 inches tip and 16 inches butt. Depth of water, 3 to 16 feet. Height of supports above water, average, 9 feet—a height equal to that of a probable flood. Current, 2 to 7 miles per hour, average, 4½. Best speed per day of ten hours, thirty-two piles. Best speed fifty consecutive working hours, 1,500 linear feet dike. Distance of bents apart, usually 20 feet. Wire cable, diameter three-quarters inch. Drift-boats one-half and five-sixteenths inch, round iron. Penetration of piles, 6 to 24 feet; average, about 14 feet. In this connection, the aids and resistances to penetration of piles sunk by the jet are most important topics. In this season's work, the earlier part was largely experimental and the full capacity of the plant hardly brought out because of the imperfection of certain details, afterward modified and more or less perfected. I have no doubt that the weakest point of the season's plant was the method of jet application. In general it was convenient and effective, but if a staple gave out or the marline parted, the pile should have been pulled up. In the latter part of the work, after experience was gained, the pile was taken out and set properly, but possibly the want of penetration in the early work may be attributed as much to the slipping of the nozzle from its proper position as to the obstructing influence of impenetrable substrata.

Piles which only penetrated the surface stratum, usually very light in character, were



›n observed to have moved bodily downstream several feet and with some inclina- ı in that direction. When they penetrated only one of the hard substrata they ıld, if inclined at all, tip slightly downstream as if rotating about the point of ıetration of the hard layer.

›ccasionally the jet, usually applied at the side of the pile, would apparently dig a e in hard strata not concentric with the pile-butt, and some time would be taken in dropping the pile in. Toward shore these hard layers of clay and coarse sand, ›roximating to gravel, appear thicker and nearer together.

have observed instances where the resistances to pile sinking might be attributed the aggregation of coarse sand and gravel at the bottom of a jet-hole sufficient to ›vent further excavation, as the jet had not power enough to force the pebbles up d out of the hole. The head-line strain used to add energy to the descent of the pile, regarded as indispensable. It should be applied intermittently and always as nearly possible in the direction of the pile's axis. A certain amount of jarring or lateral ›tion during the descent of the pile will greatly accelerate it, and, in many cases is ›o indispensable. To supply this motion effectively and simply is still a matter ›uiring some further study. An estimate of a maximum attainable speed for ten urs presupposes that the apparatus is in good working order, that conditions of the rer and weather are favorable, that the piles are delivered in the right shape and ›t enough, and, more than all, that the foreman has brains enough to and does work e outfit for all it is worth. We will suppose a bent to be completed and the outfit ady to make a fleet: Time of fleet, during which hose, hoist, and heel-line attach- ›nts are made, should not exceed three minutes; hoist to position, one minute; sink- g, average, three minutes; casting loose the pile-set and swinging out, if necessary, ree minutes, during which time another pile is made ready; hoist to position, one inute; sinking, three minutes; time between two successive fleets, say fifteen minutes ›r bent, four bents per hour; forty bents or eighty piles per day of ten hours. This ay not be the maximum theoretical capacity, but it is an ample estimate possibly :acticable by a good plant and a well-trained crew. One-half this maximum, twenty ›nts or 400 linear feet of dike per day of ten hours, is a pretty good average; 600 near feet can easily be attained by good plant and crew under ordinary circum- ances.

The greater the inclination of the current with the dike, the greater the difficulty ı making the fleet. Conclusions as to the proper inclination of dike must soon be ›ached experimentally, and until then it is not pertinent to put limitations upon the .ze and arrangement of the barges.

The time required to make fleet is nearly independent of width, weight, or number f necessary barges, if only one rests against the finished bents, and the center of the tream's pressure on the system is above the point of contact with the last-finished ent. The time wasted in putting in a thousand feet of dike is appalling, and is simply he aggregate of a thousand and one little delays, insignificant in themselves but ›rmidable in the grand total. By careful observation and management, devices and ıethods may be worked up, and these leakages stopped.

A most troublesome cause of delay is in the numerous lines necessary to work the ›lant. These should be made as few as is consistent with safety and speed.

In the first place, the plant should be simple and strong, but when small or perish- ›ble details are unavoidable, duplicates should be kept on board and ready to adjust ›t a moment's notice.

In a drilled crew every man should have his particular duty to perform and enough ›f it to keep him from losing interest in his work. It is hardly pertinent to enlarge ›pon the advantages of a good crew in this connection, but the man who spends all ›is time in elaborating his plant and allowing roustabouts to run it would do as good ›ork from a skiff with a hand-pump. When the financial aspect of affairs will war- ›ant it, a picked crew paid by the year should be employed, and the spring spent in ›riving piles rather than in educating a green gang.

The following is a statement of the cost of the pile and tripod dike work of this ›eason:

LABOR.

Pile screen dikes, 1882:		
Supports	$1,628 41	or 22¼ cents per linear foot.
Screen	595 27	or 8¼ cents per linear foot.
Anchorage	629 05	or 8¾ cents per linear foot.

MATERIAL.

Pile screen dikes, 1882:		
Supports	3,392 37	or 49 cents per linear foot.
Screen	326 31	or 4½ cents per linear foot.
Anchorage	122 03	or 1⅝ cents per linear foot.
Total cost		94⅜ cents per linear foot.

LABOR.

Shore dikes, 1882:

Supports	57 13 or	1¼ cents per linear foot
Screen	49 86 or	1¼ cents per linear foot
Anchorage	82 56 or	2¼ cents per linear foot

MATERIAL.

Wire	150 00 or	3$\frac{7}{16}$ cents per linear foot
Total cost		8¼ cents per linear foot

SURVEYS.

A complete survey of the reach was begun in September and completed during December.

Discharge observations at Florence have been in progress during the month of June and are not yet completed.

A set of charts of comparative cross-sections accompanying will illustrate, without further comment, the changes brought about by the training works.

I desire to recognize at the close of the season's operations the valuable assistance of Mr. Wynkoop Kiersted, jr., assistant engineer, in surveys, and of Mr. A. J. Grove in construction.

SUPPLEMENTAL

After writing the above, about 1,200 linear feet of the profile dike work along the line of proposed Iowa shore was scoured out. The break begins at 1,000 feet below the upper end of the dike.

The work withstood the strain so long, however, that I do not regard the damage as of any particular moment. The cross-sections indicate that the result sought has been fairly well obtained in clearing out the Florence Pocket Bar and forcing the channel into the pocket.

Very respectfully submitted.

Charles S. Pease,
Assistant Engineer.

Maj. Charles R. Suter,
Corps of Engineers, U. S. A.

S 14.

IMPROVEMENT OF MISSOURI RIVER AT SIOUX CITY, IOWA.

During the past season a wire-screen dike was projected from the right bank of the river 2 miles above Sioux City, its object being to regulate the channel in front of Sioux City. This work, which was successful, will be extended during the present season, and the Covington revetment will be extended and strengthened if necessary, the work being done under an allotment from the general appropriation for improving Missouri River from its mouth to Sioux City, Iowa.

The work was in charge of Assistant S. H. Yonge.

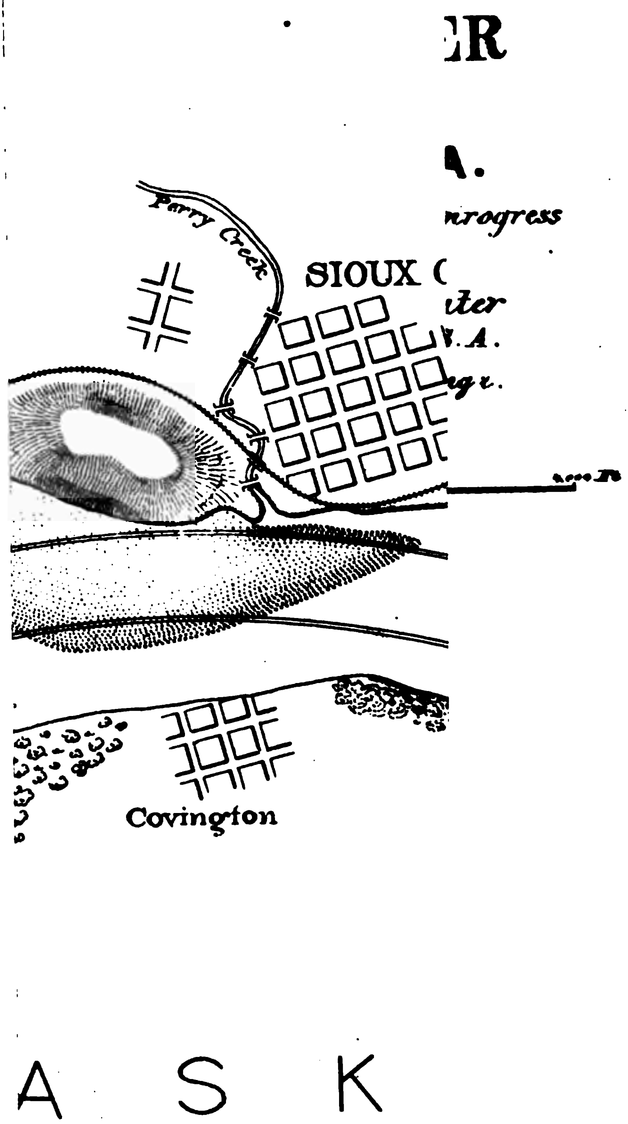
The work is situated in the collection district of New Orleans, and the nearest port of delivery is Omaha, Nebr. The nearest fort is at Leavenworth, Kans.

Amount of revenue collected at Omaha, Nebr., during fiscal year ending June 1882, was $4,525.82.

Money statement.

July 1, 1881, amount available	$11,077
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	10,596
July 1, 1882, amount available	481

PLATE I



REPORT OF MR. SAMUEL H. YONGE, ASSISTANT ENGINEER.

SIOUX CITY, IOWA, *June* 30, 1882.

MAJOR: I have the honor to submit the following report of operations conducted at Sioux City, Iowa, for the fiscal year ending June 30, 1882:

During the early part of the year the barges and other plant necessary for constructing the proposed training works in the vicinity of Sioux City were completed and the machinery set up and tested.

It being impossible to procure piling until after the June rise of 1881 had passed, it was decided to suspend operations until the spring of 1882.

It was believed that works constructed so late in the season at a low stage of water would not produce results of any material benefit. The barges belonging to the work were therefore hauled out on the bank and placed in charge of a watchman.

The river opened March 3, and preparations for work were begun early in April. These preparations were completed April 19; the plant was then towed to the site of the proposed work, and operations were commenced April 29.

Owing to changes in the regimen of the river above Sioux City, slight modifications were made in the lines of the project, as proposed in my letter of June 21, 1881. The new lines are shown on drawing, marked Plate I. It is proposed by these works to contract the river to a proper width and to train it along the Sioux City front, restoring approximately the shore lines as they existed previous to 1870, elongating the stream's thalweg about 10 per cent., with a view to effecting a decrease of slope, thereby improving navigation and providing a better harbor at Sioux City.

The portion of the project selected for the season's work, and which was completed May 27, is shown on Plate I. It extends from A to B, a distance of 1,315 feet, gradually leaving the shore of Willow Island until at its lower extremity the distance from this bank is 300 feet.

The work consists of a longitudinal training dike, forming the concave side of a bend of 10,000 feet radius. The details of its construction are as follows: Two parallel rows of piles were sunk 14 feet apart in 14 feet bents. The stream line of piles was braced longitudinally by waling 7 inches in diameter, notched out and drift-bolted to the piles; the two lines were connected by diagonal braces of cottonwood poles about 6 inches in diameter, wired together at their intersection, and spiked to the piles. The plane of the bracing system was placed slightly above that of ordinary high-water. A line of wire netting, stretched along the face of the stream line of piles and attached to the waling and piles by wire and staples, forming a continuous screen, completed the construction of the dike.

The netting was not anchored, there being no rock on hand and no means available for procuring it.

The netting was manufactured during the summer of 1881, of No. 12 annealed wire, in sections varying from 8 by 20 feet to 19½ by 34 feet. Its mesh was diamond shape 12 by 12 inches, and a strand of No. 8 wire was used for selvage. Owing to the small balance of funds available for construction the work done was limited in extent. It has, however, furnished a class of experience that will be valuable in future operations.

The material composing the bed of the river in the vicinity of the work consists of a very compact clay, deposited by the Big Sioux River, which, previous to the cut-off of 1876, had its confluence with the Missouri about 1 mile above Sioux City. This clay is overlaid by fine sand, deposited by the Missouri, which scours out during floods.

The pile-sinking plant consisted of two barges; one, 82 by 16 feet by 34 inches, carrying a boiler, steam-pump, and steam-windlass; the other, 35 by 18 feet by 34 inches, carrying a boom derrick and an elevated platform. The derrick was placed near the middle of the boat, and was stayed by two stiff guys on the side next the large barge, and two wire-rope guys at the stern, allowing the boom a clear swing over the bow and one side. The elevated platform across the bow of the boat was 3½ by 17½ feet, carried by seven frames 10 feet high, spaced 2½ feet. The arrangement of barges when in position for work, and the disposition of machinery and appliances, is shown on Plate II. An open flat-boat, 45 by 12 feet by 30 inches, laid alongside the derrick barge, carried the supply of piles.

The pump, which was of the Worthington duplex type with inside plungers, 10–6 by 10 inches, having a rated maximum capacity of 245 gallons per minute, supplied the water-jet. The windlass was one of standard pattern, manufactured by Copeland and Bacon, with one 8 by 8 inch cylinder, geared one-sixth, and provided with two 8-inch heads.

Different ways of preparing the butt end of the piles to receive the pipe nozzle were tried, several of which are shown on Plate III, Figs. 2 to 6. The best results in sinking piles and withdrawing piles were obtained in using the grooved form shown in Fig. 6.

The water connections between the pump and pile consisted of 21½ feet of 2½-inch pipe, terminating in a vertical pipe of same diameter 11½ feet long, placed on the machinery barge near the elevated platform; to this was attached a 50-foot length of 2½-inch rubber hose; to this, again, a 2-inch discharge pipe 17½ feet long, with a reverse bend at its lower end terminating in a nozzle 1½ inches in diameter.

The details of the nozzle and its application to the pile are shown on Plate III, Fig. 1.

To prevent the pipe slipping or being pushed out of the groove, two 6-inch cast spikes were driven, as shown in Fig. 6, Plate III. A large staple encircling the nozzle end of pipe would be an improvement on this detail. The upper end of the pipe was held by a half-inch line passing down through a staple, thence to the upper end of pile. The method pursued of handling and sinking piles was briefly as follows: The down-haul and pipe-fastening lines were made fast by a timber hitch near the head of the pile, and a chain sling for hoisting was made fast at its middle. The pile was then lifted by derrick and swung to the intersecting angle of the two boats, the pipe was inserted in the groove, and its head secured by the pipe-fastening line passing through staple. The pile was then secured loosely by chocks in the guides fastened to platform, pump started, pile lowered to bottom, down-haul led to winch-head, and a slow steady pressure applied. When sunk to a required depth, the pipe-fastening line was cast off and the pipe withdrawn by derrick, the water being shut off after the pipe was started up.

The amount of pressure applied to head of pile was estimated to be from 2,000 to 3,500 pounds. When working in a sluggish current it was found necessary to retain the pressure on the pile for about one minute to allow it to become bedded. In a strong current this was unnecessary, and the down-haul line was cast off as soon as the pipe was withdrawn. In several instances, when the pile refused to penetrate deeper in the clay, the nozzle pipe was withdrawn without stopping the pump, and pressure being again applied to the pile it was forced down an additional depth of from 2 to 4 feet. If the descent of the pile was checked, as sometimes occurred from forcing it down too rapidly, it was hoisted about two feet and the jet allowed to clear the way, when the operation of sinking was continued. Attempts to aid the descent of the pile by jarring or imparting a lateral motion produced little or no effect.

The steam pressure at boiler varied in different cases from 40 to 80 pounds. The speed of running pump was from forty to sixty strokes per minute for each plunger, being regulated by the throttle-valve, which could not be opened more than about two-thirds for boiler pressures exceeding 60 pounds without drawing over water from the boiler, causing the pump to pound badly.

From experiments made with streams playing in the open air, the efficiency of the pump was ascertained to be about 80 per cent. of its rated capacity at working speeds. The quantity of water used, therefore, varied from 80 to 120 gallons per minute. The following table contains some of the data collected in these experiments, and covers the limits of pressure and discharge used at this point in pile sinking. The nozzle pressures were determined from friction co-efficients given in Ellis's work on Fire Streams. The water-discharge connections were the same as used in pile sinking, with the omission of the 11½ foot section of 2½-inch pipe.

TABLE.

Throttle open (estimated)	One-third.	Two-thirds.	One-third.	Two-thirds.
Steam pressure at boiler............pounds..	40	40	80	80
Water pressure at pump ....do....	35	45	60	84
Number of strokes per minute each plunger ....do ...	40	45	52	75
Discharge per minute in gallons.......do....	80	90	104	150
Friction loss in hose and pipes ....do....	3	3.4	4.5	9.2
Calculated nozzle pressure ....do....	32	41.6	55.5	74.8
Distance of solid stream in feet*	25	20	15	None.
Spray to ground	40	50	45	60
Total distance	60	80	68	102

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* Distance of solid stream was measured by distance from nozzle, at which the stream enlarged to about 3 inches in diameter.

As there were no other barges on hand besides those described, it was necessary to attach the bracing system as the work progressed, so that but one crew, consisting of engineer, boatman, and four or five laborers, was engaged alternately in sinking and bracing.

The piles were tamarac and Norway pine, 30 to 40 feet long, 8 to 12 inches butt diameter, and not over 6 inches out of wind. The depth of water in which work was carried on varied from 2 to 15 feet; the current, at times, was sluggish, though generally very swift, depending in a great measure on the force and direction of the wind. The time occupied in shifting position of barges and sinking two piles, with an average penetration of 23 feet, under favorable circumstances, was about 15 minutes. As the work progressed and the manipulation of the appliances became better understood, the improvement in speed was marked. During the first and second weeks an average penetration of about 28 feet per hour was attained; during the third week, 40 feet; the fourth week 100 feet, and, during the last day's work the average speed was 130 feet per hour. The average penetration per pile throughout the work was about 23 feet, 10 of which was through sand and 13 through clay. The maximum penetration was 29 feet, 11 of sand and 18 of clay. Only two piles were sunk to a less depth than 17 feet and very few less than 23 feet.

These results show the feasibility of obtaining deep penetration for piling through tough clay with the water-jet, and it is believed that with slight modifications in the details of some of the appliances, penetration of 35 feet in clay can be made if desirable, and that with a trained crew and one set of plant a working speed of 1,800 feet penetration per diem is attainable.

The principal modifications in the plant used at Sioux City would consist in a larger boiler with abundant steam space so as to run the pump to its full capacity, and a more perfectly constructed discharge pipe 3 inches in diameter with 1¼-inch smooth nozzle. As an example of the great economy both in time and cost of the water-jet system of pile sinking over that of using the ordinary pile-driver, it may be cited that under circumstances very similar as to character of material, &c., to those under which the Sioux City dike was constructed, an average day's work for a crew with pile-driver on barge, in this vicinity, is four to five piles driven from 15 to 20 feet, or a maximum penetration of 100 feet per diem.

Bad weather and unavoidable delays in getting materials on the ground caused many interruptions to the work and increased its cost.

The following is a detailed statement of the cost of dike per running foot:

STATEMENT.

	Cost.	
Material:		
Piles	$0 57.47	
Walings	12.26	
Bracing poles	5.05	
Drift bolts, spikes, staples, and, etc	2.20	
Netting	28.00	
Fuel (for steaming)	2.27	
Total cost of material per running foot		$1 07.25
Labor:		
Grooving piles	$0 02.56	
Sinking piles	07.01	
Waling and bracing	08.15	
Attaching netting	01.36	
Transporting material, &c., to dike	11.04	
Engineering, superintendence, watching, &c	28.13	
Total cost of labor per running foot		0 58.25
Total cost of dike per running foot		1 65.50

The net cost of labor and fuel per foot of penetration was 2.8 cents.

Under the head of material it will be observed that the items of piles and walings were expensive; this was due to scarcity of suitable timber in this neighborhood, making it necessary to procure the supply from Wisconsin. Under the head of labor the cost of engineering, superintendence, &c., is disproportionately in excess as compared with total cost of labor; this resulted from interruptions to the work by stormy weather and the limited supply of plant which prevented the employment of a larger force. This item would be reduced to an insignificant sum in carrying on works of any magnitude.

The work has thus far withstood the high water satisfactorily, and, though the force of the current along the line of the dike has been at times very severe, none of the piles have been washed out.

The only damage suffered was occasioned by a large mass of heavy drift lodging between the piles and forming an immense wreck heap, which resulted in breaking off the piles and destroying about 200 feet of dike at the lower end. The occurrence of such accidents can be readily guarded against in future works by using heavier piling for exposed positions.

The effect produced by the dike after the June rise began, in changing the shape of the cross-section and distributing the flow of the stream opposite Sioux City, has been very satisfactory, exceeding in extent what had been anticipated.

During the present June rise the center of gravity of the Sioux City discharge section has moved toward the Iowa shore about 100 feet, whereas the tendency at flood stages during the last few years has been in the opposite direction. As no change of any importance in the regimen of the river has occurred between the head of Willow Island and Sioux City, this effect must be ascribed to the action of the dike, and warrants the opinion that useful results of a positive character would be secured by a further extension of the work downstream, and giving it the proper reinforcement of supplementary cross-dikes, connecting it with the right bank.

As to the final results of the work in its incomplete state, little can be predicted in advance of the low water stage.

At the close of operations last month the barges and other public property were taken to Sioux City and laid up in a place of safety.

In conducting the work at Sioux City I have been assisted by Mr. R. H. Bacot in an efficient manner.

I am, major, very respectfully, your obedient servant,

SAMUEL H. YONGE,
Assistant Engineer.

Maj. CHARLES B. SUTER,
Corps of Engineers, U. S. A.

S 15.

IMPROVEMENT OF MISSOURI RIVER AT VERMILLION, DAKOTA.

The cut-off at Butler's during the spring of 1881 having averted the danger that threatened the town of Vermillion, the work was transferred to a point 14 miles above, where the conditions were favorable, and the systematic regulation of the river was begun. A wire-screen dike, with pile supports, was run out from the right bank to a length of 8,000 feet, and, although it had only been barely completed at the close of the fiscal year, the results obtained have been quite remarkable, as shown by photographs, &c., appended to the accompanying report of Assistant C. F. Potter, who had charge of the work.

In accordance with your instructions, this work will be turned over to Capt. Edward Maguire, Corps of Engineers, U. S. A.

The work is situated in the collection district of New Orleans, and the nearest port of delivery is Omaha, Nebr. The nearest fort is at Leavenworth, Kans.

Amount of revenue collected at Omaha, Nebr., during fiscal year ending June 30, 1882, was $4,525.82.

Money statement.

July 1, 1881, amount available	$19,585 14
Amount received, sales of fuel to officers	19 12
	19,604 26
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	15,092 45
July 1, 1882, amount available	4,511 81

REPORT OF MR. CHARLES F. POTTER, ASSISTANT ENGINEER.

VERMILLION, DAK., *July* 1, 1882.

MAJOR: I have the honor to submit the following report upon the work of improving Missouri River in the vicinity of Vermillion, Dak., for the year ending June 30, 1882. The work of construction consisted chiefly in carrying out the project submitted February 7, 1882.

A dike 8,000 feet in length has been constructed, commencing 300 feet above △ 5, and running on a curve of 6 miles radius, as indicated on map.

The plant was built at Yankton, Dak., during the fall and winter, in accordance with plans submitted June 18, 1881. Yankton was chosen as a favorable point for boat-building, as it has superior advantages in cost of transportation of material and its existing steamboat-ways favorably located for launching. The boats, five in number,

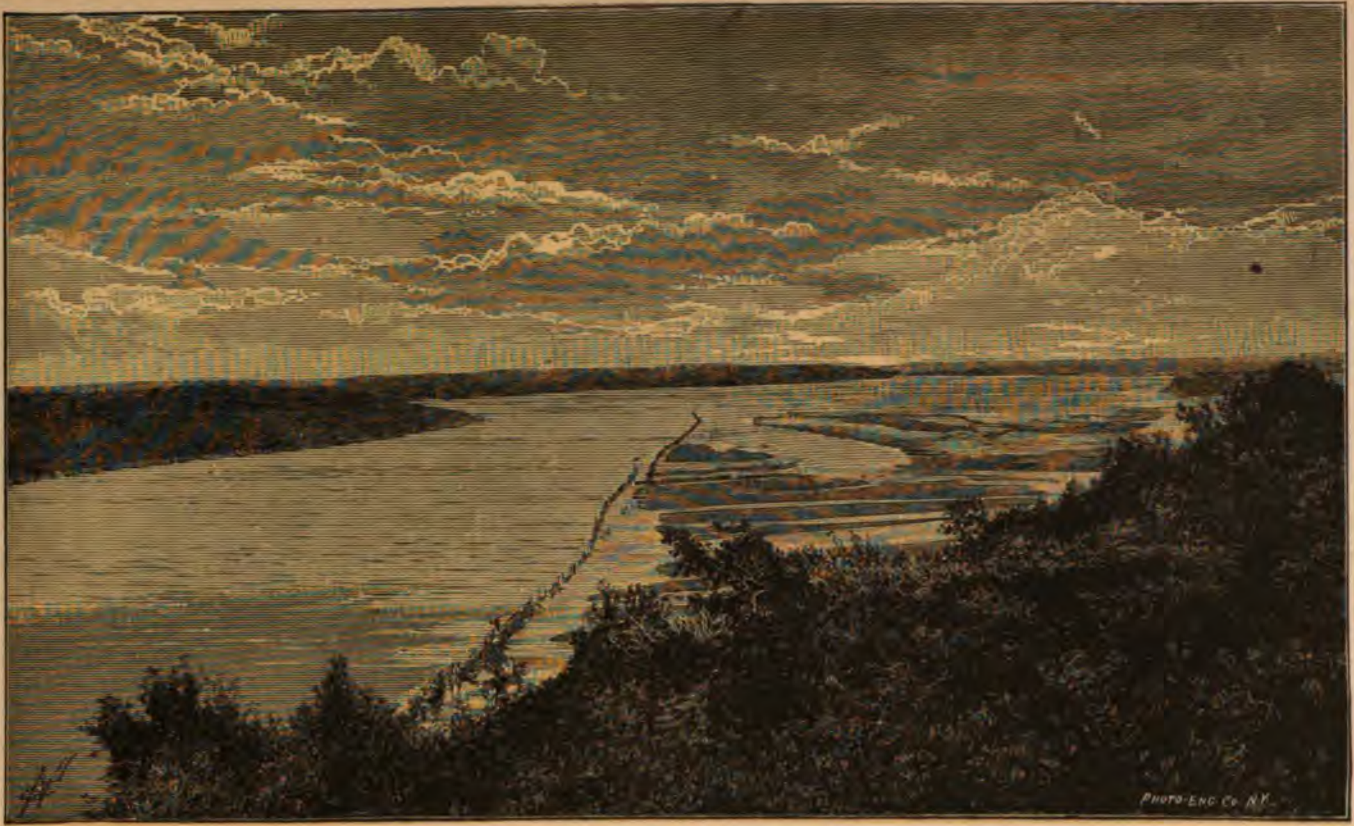
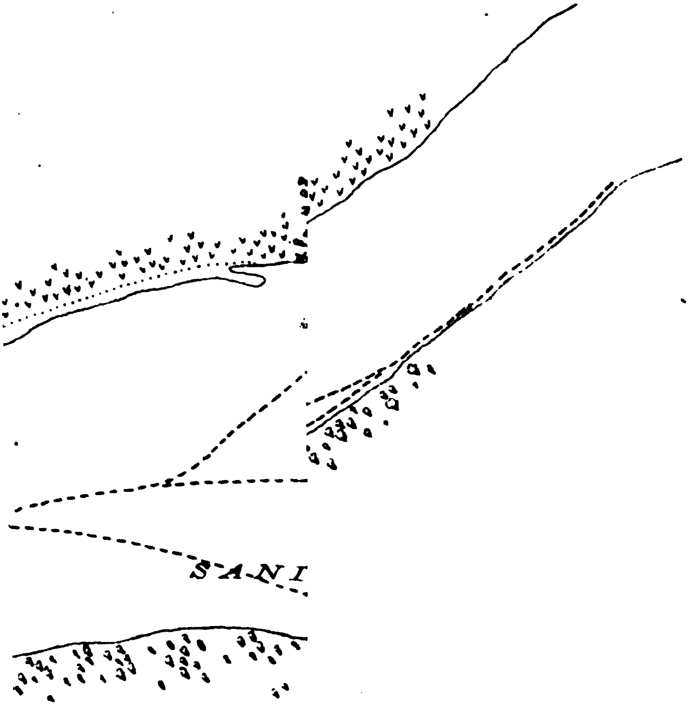


PHOTO-ENG Co. N.Y.

SCREEN-DIKE AT VERMILLION, DAK.

[Looking down stream from Nebraska Bluffs. Gauge 70.7′, or 2.5′ above low-water. August 18, 1882.]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were launched as soon as the ice permitted, and were floated to the scene of this season's operations, reaching there on April 11.

Considerable time was then spent in making preparations for dike work, as in quarrying rock, preparing piling, completing netting machine, and building lodging and tool houses.

The dike was commenced the last week in April. It consisted of piling sunk vertically, 20 feet apart, on the line, and connected with horizontal waling-drift bolted in place. The wire screen was anchored at the ground edge and securely fastened to the waling at the other.

The low stage of water during the month of May caused much inconvenience, as at several points on the line of dike water was insufficient to float the boat.

The work was suspended a short time previous to the June rise, in order to allow a a navigable channel to develop on the Dakota side between △ s 12 and 14, as the main channel at this time was nearly crossed by the dike. Before work could be resumed, the rise, with its heavy drift, reached us, rendering the boats unsafe in the strong current.

The wire netting attached to the piling resisted the drift for one week of the rise without any material weakening, but after that time the wires broke rapidly under the heavy and accumulating load of *débris*. At this time, however, a bar had formed behind and along the entire line of the screen from 1 to 3 feet below the surface of the water. As soon as the breaking of the wires was noticed, the placing of a second screen over the first one was begun.

On June 21 the course of the river changed above Saint Helena Island, which resulted in the current striking the Dakota bank a short distance above the head of the work, then crossing and striking the dike opposite △ 7 at an angle of about 60°.

In a short time a break was made, which increased to a considerable length during the day and night. The following day the direction of the current changed back, running with the dike and cutting a small channel behind it. A force has been employed during the past week in repairing the break by means of stiff weeds.

A continuous buoy-dike was intended for this purpose, but it was found too difficult to place in position, owing to the drift and swift current. As soon as the drift will permit and the weeds shall have produced their effect, piling will be sunk and the former dike replaced.

The effect of the dike has already been good in the bend between △ 10 and △ 14, but this bend is not yet sufficiently developed to warrant an expenditure of money in revetment. It is thought, however, that by August the bend will have attained the desired shape, and protection of its banks will then be in order.

During the winter, while the river was frozen over, levels were carried across at various points, and bench-mark stations established on the Dakota side, all levels having been previously run on the Nebraska side. A cross-section of the valley, just above Vermillion, was leveled, and probings made to rock at several stations on the section.

JET PILE SINKING.

The apparatus used for sinking piles consists, mainly, of a boat 82 by 18 by 3 feet, carrying a derrick with 22 feet mast and 24 feet boom, a 10–5½ by 10 inch duplex pressure pump, and a steam windlass for lifting. Steam was supplied to the pump and windlass by an 8½-foot by 37-inch upright boiler. A boat, 35 by 16 feet, used as a tender, and placed across the end of the larger one, carries a platform, from which the pile is guided while it is sinking.

A 2½-inch gas-pipe, connected by hose to the pump, is placed on the side of the pile and the jet applied at the bottom, as shown in accompanying illustration. A nozzle is formed by drawing out the end of the pipe from 2½ inch to 1⅞ inch diameter.

The depth of penetration has not been as great as desired, the average being about 17 feet and the maximum 22 feet..

The need of a larger pump is felt. We have used on an average 200 gallons of water per minute at 60 pounds pressure, steam pressure being at 80 pounds. A pump with a capacity of 300 gallons per minute at 70 pounds water pressure would be nearer the size required. The best working speed attained in sinking thus far is thirty-eight piles in six consecutive hours.

The piling used were not less than 6 inches in diameter at the smaller end, and ranged from 25 to 40 feet in length. It is thought that a diameter of 10 inches at the smaller end would be more satisfactory.

WIRE NETTING.

The netting or screen wire was made continuous from a boat, and varied in width with the depth of water. For the first 7,000 feet of dike no water was found over 6 feet deep at the time the screen was made, consequently 30 feet was adopted for the width over this portion. When deep water and a strong current were reached, a width of 15 feet was added to the screen. The selvage edges were re-enforced by a strand

four No. 10 wires, one being attached to the waling and the other anchored at the bottom with 10 pounds of rock per linear foot.

For the 30-foot screen a mesh of 1.75 square feet area, made of No. 14 wire, was used, while for that 45 feet wide the area of mesh was doubled and No. 12 wire used.

The smaller mesh has been found to best resist the action of the drift, as logs striking it at a small angle will either bound off or lie alongside, while in the screen of large mesh they will work through and break the wires.

The machine for making the screen consisted of a drum, made in 15-foot sections, with radiating arms that can be changed so as to make the diameter of the drum adjustable within the limits of 4 to 6 feet, and thus vary the size of the mesh.

WEEDS.

The weeds now being used for repairing the dike are the old form of stiff weeds made in 25-foot sections, each one being anchored with 2 tons of rock. Hardwood brush is used, varying in diameter at the butt from 2 to 4 inches.

I desire to acknowledge the efficient services of Mr. J. C. Meredith, who superintended building the plant now in use, and who has since had immediate charge of the works of construction.

I am, major, very respectfully, your obedient servant,

CHAS. F. POTTER,
Assistant Engineer.

Maj. CHARLES R. SUTER,
Corps of Engineers, U. S. A.

S 16.

IMPROVEMENT OF MISSOURI RIVER FROM KANSAS CITY TO ITS MOUTH.

This appropriation was entirely devoted to snagging operations which extended over the river from its mouth to Kansas City, a distance of 375 miles, the snag-boat H. G. Wright being employed. She was working near Miami at the beginning of the fiscal year, and was kept at work till December 9, 1881, when she was laid up for the winter. The spring being early she was started out again February 11, 1882, and worked till the end of April, when she was finally laid up at Saint Louis, the appropriation being about exhausted. She was in commission eight months and worked six times over the river between Kansas City and the mouth.

This work is situated in the collection district of New Orleans, and the nearest port of delivery is Saint Louis, Mo. The nearest fort is at Leavenworth, Kans.

Amount of revenue collected at the port of Saint Louis, Mo., during the fiscal year ending June 30, 1882, was $1,676,951.56.

Table of work done in Missouri River.

Name of boat.	Number of snags pulled.	Weight in tons of 00 p	Number of trees cut.	Number of drift piles removed.	Number of miles run.
H. G. Wright	1,716	15,147.5	4,487	12	2,3

Money statement.

July 1, 1881, amount available	$35,000
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	34,443
July 1, 1882, amount available	556

S 17.

SURVEY OF MISSOURI RIVER FROM ITS MOUTH TO FORT BENTON, MONTANA.

During the past season a small stern-wheel steamer, the Missouri, was purchased and fitted up for the accommodation of the surveying party. After all preparations were completed, a start was made at Fort Randall, Dak., and the survey was carried down to connect with the work previously done below Sioux City, Iowa, having covered a distance of 176 miles of river. The amount of funds available would allow of no greater extension of the work. In addition to this the line of check-levels from Sioux City to the mouth was completed and the maps of previous year's work prepared for publication. During the present year it is proposed to extend the survey a distance of 500 miles and to publish the maps before alluded to. If the appropriation for next year is available in season the party will be kept in the field throughout the summer and fall, and a fair amount of progress may be expected. The distance to which this survey has now been carried renders it very costly to transport the parties to and from the field, in addition to which much valuable time is thereby lost. It is therefore expedient in the interest of economy that the party should be kept in the field throughout the entire period during which out-of-door work is possible. It is with this end in view that the estimates are made, and it is earnestly hoped that the full amount asked for will be granted, as otherwise the time occupied in the work will be unduly protracted and the cost greatly enhanced.

If the surveying party can be kept employed throughout the season two more years will suffice for the completion of the survey, a result which in the interest of all concerned is greatly to be desired.

The survey has been, as heretofore, in charge of Assistant D. W. Wellman.

Money statement.

July 1, 1881, amount available	$33,791 55
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	33,445 54
July 1, 1882, amount available	346 01
Amount appropriated by act passed August 2, 1882	40,000 00
Amount available for fiscal year ending June 30, 1883	40,346 01
Amount (estimated) required for completion of existing project	65,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	50,000 00

REPORT OF MR. D. W. WELLMAN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., June 30, 1882.

MAJOR: I have the honor to submit the following report of progress on the survey of the Missouri River from its mouth to Fort Benton, Montana, for the year ending June 30, 1882.

At the date of my last annual report the steamer which had been purchased for use on this work was undergoing repairs at Sioux City, Iowa, and other preparations were making for the continuation of the field-work above that point. At the same time two parties were engaged in running a line of check-levels over the ground covered by the surveys of 1878-'79, which work they completed about August 20, 1881, and were immediately transferred to Sioux City and attached to the party there organizing for the purpose above mentioned. The repairs to the steamer were finished about the time the level parties reached Sioux City, and on the 25th of August the party was embarked and started for Fort Randall, Dakota, at which point it was proposed to begin the season's work, and which was reached on the evening of the 30th of the month.

The field work was commenced on the 31st and continued without intermission to a connection with the survey of 1879 at Sioux City, Iowa, which was accomplished October 21, 1881.

A detailed account of the organization of the party and of the field operations for the season is given in my report of December 15, 1881.

Gauges for marking rise and fall of water in the river were established, one at Fort Randall September 1, one at Running Water September 15, and one at Yankton September 27.

Daily observations on these gauges were taken until November 1, when, on account of the difficulty of obtaining correct information through the winter months, they were discontinued.

The river, in the month of October, reached an extremely low stage, and from observations on these gauges, together with those from the Vermillion and Sioux City gauges, the approximate low water slope of the river has been deduced and is shown in the accompanying table.

As no observations were taken on these gauges during a high stage, no high water slope can be given.

Since November 1, 1881, two of the assistants and two draughtsmen have been engaged on the map work, the condition of which is as follows:

The twenty-seven large maps of the river, from the mouth to Sioux City, are completed with the exception of the revision and correction of the profile of water surface and reduction of the levels to the datum plane of the Saint Louis City directrix, which work is now going on.

The reduction of these twenty-seven sheets to a scale of 1 inch to 1 mile has been finished, and the sheets are ready for publication when funds for that purpose are available.

The notes of the survey of 1881 (Sioux City to Fort Randall) have all been platted, making six sheets of the standard size for this work (40 by 120 inches, scale 1 inch to 1,000 feet), and four of the sheets finished in ink. These six sheets have also been reduced in pencil to the scale of 1 inch to 1 mile, and three of them nearly finished in ink.

As stated in my report of December 15, 1881, owing to the fact that the compass parties had been dispensed with, and that for topography we were dependent entirely on the transit parties, the details of the topography of the valley, especially at a distance from the river, are not so full as could be wished. The general features, however, are fully shown, and the line of the bluff when out of reach or sight of the transit parties is approximately defined. It is proposed when a field party is again organized for work above Fort Randall to detach small parties while on the way up to obtain further information in special localities, to be added to the maps, and for this reason it is recommended that the publication of the maps of the river above Sioux City be deferred until such additional information can be obtained and transferred to the maps.

The public land surveys have extended along the eastern bank of the Missouri River in the Territory of Dakota, from the mouth of the Big Sioux River to above Fort Sully, excepting on the Indian reservations on that side, but time would not permit of any connection of the survey with the section lines. Our maps are therefore without information regarding the land surveys.

I recommend that in future at least one compass-man be employed to make connections with land lines as often as practicable, and to assist in defining lines of bluff when beyond the reach of the transit parties.

As mentioned in a previous report, in order to avoid the expense of organizing and maintaining an independent party for the purpose of checking the level work, as had been done below Sioux City, it was thought best to use during the progress of the survey two level parties instead of one as heretofore, each party consisting of two level-men, with necessary assistants. These parties, by dividing the estimated length of a day's work, were able to run two continuous lines of levels, every sight of the advance level being checked by the one following, and to keep pace with the balance of the work.

The accuracy secured by this method in connection with a rigid system of working was truly remarkable, the total range of difference between the main and check lines from the commencement to the end of the survey (176 miles) being 0.095 foot.

This result is so satisfactory that I recommend a continuance of the method in future.

Five hundred and fifty-one permanent bench marks have been established on the right bank of the river, besides connecting with fifty-one others previously established and which are not numbered. Of these, five hundred and fifteen are below Sioux City and eighty-seven between Sioux City and Fort Randall. Four hundred and fifty-eight are on trees, stumps, &c., forty-seven on copper bolts leaded into solid rock, and ninety-seven on stone or brick foundations, abutments, or permanent buildings. Between Sioux City and Fort Randall no rock ledge could be found solid enough to use for a permanent bench. A few were made on detached granite bowlders.

The elevations of bench marks and water surface have all been referred to the Saint Louis directrix, and a descriptive list of bench marks with elevations has been printed and bound in convenient form for reference.

Profiles of the water surface as shown by levels were made some time ago on the large maps of the river below Sioux City, the distances being measured along the right bank.

In many localities, however, the method of measurement does not show the true slope of the river. I have therefore had a channel line, as indicated by the soundings, delineated on the maps, and the distances between sounding stakes measured on that line, with a view to replatting the profiles from that data. This, in order that the length of profile and distances between towns and other points on the river may agree, has necessitated a revision of the table of distances already reported, and will increase the total distance from the mouth to Sioux City 21.8 miles over that given in the table referred to, that showing distances along a probable high water channel, while those in the table herewith submitted show very closely the length of the low water channel.

At the last session of Congress the sum of $30,000 was appropriated for the continuation of the survey for the fiscal year ending June 30, 1882. Of this amount there was required for

Finishing check levels below Sioux City	$4,743
Repairing steamer Missouri	7,123
Allotment for office expenses	1,648
Total	13,514
Leaving for survey above Sioux City	16,486

With this amount, the number of miles of river surveyed was as follows:

Sioux City, Iowa, opposite Pearl street, to mouth of Big Sioux River	3.1
Jefferson, Dak	18.9
Iowa Creek, Nebraska	28.4
Maupin's, or Patton's Mill, Dak	31.4
Walter's Woodyard, Dak	33.0
Ponca Landing, Nebr	34.8
Dixon's, or Elk Point, Dak	36.0
Ionia, Nebr	46.0
Burbank, Dak	50.8
Mouth Vermillion River, Dakota	57.4
Lime Creek, Nebraska	60.4
Mulberry Point, Dak	61.7
Wiseman's Landing, Nebr	69.9
Saint James Landing, Nebr	72.6
Bow Creek, Nebraska, Andrew's Point, Dak	73.2
Foot of Saint Helena Island	75.2
Head of Saint Helena Island	79.0
Saint Helena, Nebr	80.1
Point a'Jacques, Dak	80.8
Mouth of James River, Dakota	84.5
Campbell's Point, Nebr	88.3
Foot of Elk Island	90.0
Yankton, Dak	93.0
Smutty Bear's Camp, Dak., Frankfort, Nebr	102.6
Antelope Point, Dak	105.3
Hughes Woodyard, Nebr	110.4
Foot of Bon Homme Island	111.9
Mennonite Village, Dak., Kount's Woodyard	114.2
Bon Homme, Dak	116.7
Dodson's Landing, Nebr	118.7
Springfield, Dak	125.8
Santee Agency Landing, Nebr	128.0
Bazile Creek, Nebraska	132.2
Running-water, Dak	135.0
Niobrara, Nebr. (old town)	135.4
Niobrara, Nebr. (new town) and stock-yards	137.9
Mouth Niobrara River and site old Fort Mitchell, Dak	138.6

Ponca Creek, Dakota	13
Ponca Agency, Dakota	14
Chouteau Creek, Dakota	1
Yankton Agency, Dakota	16
Foot of Twin Island	16
Head of Twin Island	16
"The Tower," Dakota	16
Fort Randall, Dak., opposite Steam Mill, White Swan, Dakota	17

These distances are measured along the channel line, as indicated by the soundings, and are 2.3 miles in excess of those found by taking the mean of the shore line.

The appropriation is now exhausted, and nothing further can be done in the field until a new appropriation is available.

I would again call your attention to the inadequacy of the appropriations of the past two years for carrying on this work economically.

The nature of the survey is such that it is necessary to keep in employ a certain number of skilled assistants, whose services cannot be dispensed with without seriously affecting the progress as well as general quality of the work in the field. This, together with that of repairs and care of steamer, brings the annual necessary expense in any case to not less than $10,000. This amount, with a percentage for office expenses and other contingencies deducted from an appropriation of $30,000, will leave not to exceed $18,000 for field-work, and the same from an appropriation of $25,000 about $13,000. With the former sum a party can be organized and kept in the field probably three months, with the latter sum not to exceed two months.

It will be seen, therefore, that with an appropriation of $25,000 or $30,000 the amount of field-work that can be done in any one year is largely disproportionate to the necessary outlay, and this disproportion will continue to increase as the work advances up the river, for with such small sums the work each year will have to be done at the lower end of the unsurveyed portion of the river, and the distance to be traveled by the party to reach the ground will be constantly increasing and the time that can be spent in actual work constantly diminishing. Much of the field-work, also, must be intrusted to inexperienced and second-rate men, as it is impossible to procure the services of the best men for short periods of two or three months.

Economy demands that the field-work of the survey should be pushed to completion at the earliest possible date, so that the expenses can be reduced at once to that required to carry on the map-work alone.

The estimated length of river yet to be surveyed is about 1,400 miles. If funds could be had as fast as needed, the time required to complete the field-work, together with that consumed in going to and from the work, would not exceed fourteen months, and if money was available at this date three months' work could be done in 1882, six months in 1883, and five months in 1884, and would require

For fiscal year ending June 30, 1883	$50,000
For the year ending June 30, 1884	50,000
For the year ending June 30, 1885	30,000
Total, including finishing and publishing maps	130,000

If, however, not more than $25,000 are appropriated for the fiscal year ending June 30, 1883, as contemplated in the river and harbor bill now before Congress, not more than two months' work can be done in the field in 1882, and nothing in 1883, until a new appropriation is available, and unless the appropriations in future can be increased beyond $25,000 or $30,000, not more than 200 to 300 miles of river can be surveyed annually, requiring from five to seven years to complete the survey, and costing a total of $150,000 to $175,000, making the cost 15 to 35 per cent. greater than if funds could be had sufficient to keep a party in the field the entire working season until the field-work was finished.

In my last annual report I estimated that $105,000 would be sufficient to complete the survey and maps, but that was on the supposition that funds were to be available for field-work the whole of the present season, and that not less than 250 miles of river would be surveyed in 1881, which, on account of the unexpected length of time required to complete the check-levels and a corresponding reduction in the amount of money applicable to the work above Sioux City, could not be done.

For the year ending June 30, 1884, not less than $50,000 are needed to carry on the work profitably. This sum will enable a party to be put into the field in the spring of 1884, and maintained until the end of the fiscal year, by which time, probably, a new appropriation will be available and the party can be kept going the entire season.

Should the appropriation for the year ending June 30, 1883, equal or exceed $50,000, a party could take the field in the spring of 1883, and in the same manner could be ept out that whole season, thus shortening the time required to complete the field-ork as above estimated by nearly if not quite one working season.

Very respectfully, your obedient servant,

D. W. Wellman,
Assistant Engineer.

Maj. Chas. R. Suter,
Corps of Engineers, U. S. A.

LOW-WATER SLOPE, MISSOURI RIVER.

[Deduced from gauge-readings of October 20, 1881.]

Location of gauge.	Distance in miles, gauge to gauge.	Fall in feet.	Fall in feet per mile.
ort Randall			
unning Water	40.7	33,759	.83
ankton	42.8	40,342	.94
ermillion	35.9	36,515	*1.02
ioux City	56.5	45,890	.81

* Gauge near foot of cut-off.

TABLE OF DISTANCES MEASURED ALONG THE LOW WATER CHANNEL.

From the mouth to—

	Miles.
amestown Landing	7.25
ar of Commerce Point	14.58
harbonnier Bluff	19.60
aint Charles (bridge)	25.11
otterville Landing	43.84
amburg Landing	46.69
aint Albans (U. S. L.)	53.69
ugusta	61.17
outh Point	67.23
ashington	69.60
ewport	78.03
ew Haven	84.66
inckney	86.55
ridgeport	95.83
ermann	101.14
asconade River	107.29
luffton	112.50
ortland	117.40
hamois	121.0
aint Aubert	126.6
oose Creek	130.1
sbell	130.5
onnot's Mill	134.5
arkersville	137.3
efferson City (gauge)	145.8
edar City	147.3
laysville	153.9
arion	161.5
ureka	164.2
andy Hook	165.9
amestown Landing	166.5
rovidence	172.0
ocheport	186.0
oonville	197.0
a Mine River	202.8
rrow Rock	211.2
isbon	214.8
aline City	217.9
luff Port	223.3

	Miles
Glasgow (bridge)	226.5
Cambridge	234.8
New Frankfort	240.3
Mouth Grand River	256.7
De Witt	262.5
Miami	267.8
Lanesville	281.0
Gillam's Landing	287.2
Waverly	297.0
Berlin	310.2
Lexington	319.7
Wellington	325.4
Camden	333.5
Napoleon	339.7
Sibley	347.2
Missouri City	356.2
Blue Mills Landing	365.
Liberty Landing	370.2
Wayne City	375.3
Kansas City (bridge)	386.5
Wyandotte	389.5
Quindaro	394.9
Parkville	397.9
Pomeroy	405.7
Connor's City	406.6
Delaware	411.2
Leavenworth	416.
Fort Leavenworth (bridge)	418.9
Weston	424.6
Kickapoo	428.7
Iatan	433.6
Port Williams	437.1
Atchison (bridge)	445.2
Doniphan	452.7
Geary City	462.1
Palermo	472.1
Saint Joseph	479.5
Belmont	485.5
Amazonia	499.
Dallas	507.
Charleston	511.5
Mount Vernon	515.
La Fayette Landing	517.
Iowa Point	524.
White Cloud	530.
Nemaha River	535.
Rulo	542.
Arago	552.5
Hemmes' Landing	561
Saint Dervin	565.
Hillsdale	568.2
Aspinwall	571.
Nemaha City	573.9
Brownville	579.9
Sonora	584.9
Peru	588.1
Otoe City	598.9
Nebraska City	608.5
Oppie	615.
Wyoming	618.3
Jones Point	623.7
Rock Bluff	628.4
Plattsmouth (bridge)	635.3
Plattsmouth	639.2
Mouth of Platte	640.
Mouth of Papillon Creek	646.4
Bledsoe's Landing	652.3
Council Bluff Landing	658.4
Omaha (bridge)	667.

	Miles.
Florence	678.6
Rockport	683.0
Blair (California Junction)	699.1
Sand Point (ferry)	711.2
Little Sioux River	728.4
Decatur	749.3
Blackbird Hill	759.7
Omaha Mission	767.7
Omadi Landing	791.4
Dakota City	796.6
Sioux City	802.8

S 18.

IMPROVING GASCONADE RIVER, MISSOURI.

During the low-water season of 1881 two parties were organized and provided with the proper equipment for removing snags and other obstructions from the river. This work began in August and continued till high-water in November, and the near approach of winter drove the parties from the field. The work executed was very thorough and afforded great relief to navigation. During the present season this work will be continued, and it is also proposed to test the possibility of improving the navigable depth of the stream within reasonable limits of expense by experiments conducted on some of the worst shoals in the river.

The work has been in charge of Assistant T. T. Johnson.

This work is situated in the collection district of New Orleans, and the nearest port of delivery is Saint Louis, Mo. The nearest fort is at Leavenworth, Kans.

Amount of revenue collected at the port of Saint Louis, Mo., during the fiscal year ending June 30, 1882, was $1,676,951.56.

Money statement.

July 1, 1881, amount available	$11,069 50
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	10,535 19
July 1, 1882, amount available	534 31
Amount appropriated by act passed August 2, 1882	10,000 00
Amount available for fiscal year ending June 30, 1883	10,534 31
Amount (estimated) required for completion of existing project	25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	25,000 00

S 19.

IMPROVEMENT OF MISSOURI RIVER FROM ITS MOUTH TO SIOUX CITY, IOWA, &c.

The passage of this appropriation fairly inaugurates the thorough and systematic improvement of the Missouri River, and, if followed up, will, it is hoped, enable results of great value to be attained. Heretofore small appropriations have been made for the benefit of isolated points scattered over 1,000 miles of river, and no continuity of work was possible. The funds were so scanty that no proper plant could be procured, and it was necessary to resort to makeshift devices and weak constructions, to the great detriment of economical work. Moreover, as no piece of work could ever be finished nor any plan be thoroughly carried out, the works put in have frequently failed and required renewal, so that although the aggregate amount of money expended has been considerable, yet the results accomplished have been meager and unsatisfactory. Under the new dispensation of affairs it is proposed to concentrate the work, to make it thorough and complete, and continuous, so far as is compatible with the necessary rapidity of execution. The principles upon which the proposed work is based, and the general plan to be followed, were fully described in my report of February 2, 1881, published as House Ex. Doc. No. 92, Forty-sixth Congress, third session, and republished in the Annual Report of the Chief of Engineers for 1881, Part II, page 1649, Appendix S 17. It will only be necessary to state that the ruling idea is to contract the river bed to such limits as will insure stability of regimen and approximate uniformity of slope, width, and depth at all stages, while at low water a maximum channel depth of about 12 feet may be expected. Incidentally it is hoped that when the improvement is completed a decided lowering of the flood-line will take place, thereby protecting the valley from overflow, while the general revetment of caving banks will prevent the destruction of immense amounts of most valuable farming land. The methods to be followed will consist in reclaiming, by deposits from the river itself, such portions of its bed as lie outside the lines of the regulated channel-way, with the expectation that these deposits will ultimately be built up to the normal height of the banks and form the new shore lines of the regulated river. These deposits will be induced by the use of permeable dikes, which will check the current of the river sufficiently to cause it to drop a portion of its load of suspended sediment, while at the same time they, by their construction, will not invite the destruction which has invariably attended any attempt at massive work. The old and also the newly formed banks will be protected from erosion by brush mattresses to low water mark. Above that point the banks will be graded to a flat slope and protected by a covering of brush and stone. These methods are no longer experimental, as work on this stream and on the Mississippi has fully demonstrated their capacity, while their relative cheapness has rendered the improvement of these great rivers financially possible.

In an improvement of this kind it would be obviously desirable in the interest of navigation alone to extend the work from the mouth of the river upward, taking, say, the lower 100 miles first, then the next 100 miles, and so on, so that the range of good navigation would become at once available for all boats entering the river. In the present case a deviation from this simple plan was necessary, owing to the wording of the law, and the obvious necessity of preventing the entire loss of the incomplete works heretofore undertaken by the government. It has, therefore, been decided, with your approval, to initiate the work on that portion of the river lying between Charleston, Kans., and Lexington, Mo., a distance of 186 miles, which embraces within its limits five of the localities where work has been heretofore in progress. Of this section of river it is proposed to complete the improvement as soon as possible, and then to extend the work over the other portions as rapidly as the funds appropriated will allow.

For convenience of administration this reach has been divided into three divisions under charge of competent engineers, and each division will have a complete and independent engineering staff and equipment of plant. As the work progresses the limits of these divisions will be extended, or new ones will be created, as may be found most expedient in practice.

To carry on this work successfully and rapidly will require a very extensive plant, which must be procured during the coming winter. The equipment now available will only allow of a limited amount of work this fall, but by next spring I hope to have everything in readiness for expending any amount of money that Congress may see fit to allot for carrying on the work. The amount asked for—$1,000,000—is the smallest sum that can be profitably expended per annum; though in my opinion double that amount could be utilized; with, of course, the advantage of an earlier realization of decisive results.

In addition to the work here outlined work will be prosecuted with allotments from the general fund at the following localities, where work has been heretofore in progress, and where the interests involved seem important enough to justify this diversion of funds:

Saint Charles, Mo., allotment	$22,000
Glasgow, Mo., allotment	30,000
Nebraska City, Nebr., allotment	33,000
Omaha, Nebr., allotment	20,000
Sioux City, Iowa., allotment	15,000
Total	120,000

The general allotment of the appropriation which has been approved by you is as follows:

For purchase and repair of plant	$400,000
For continuing old works	120,000
For work under general project	330,000
Total	850,000

which sum will undoubtedly all be expended at the close of the present fiscal year, and it is earnestly hoped that Congress will, by timely appropriation, provide for the continuance of the work without expensive and annoying delays.

ESTIMATE.

For prosecution of work	$1,000,000

Money statement.

Amount appropriated by act passed August 2, 1882	$850,000
Amount available for fiscal year ending June 30, 1883	850,000
Amount (estimated) required for completion of existing project	7,150,000
Amount that can be profitably expended in fiscal year ending June 30, 1884	1,000,000

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S 20.

EXAMINATION OF MISSOURI RIVER AT OR NEAR ARROW ROCK, MISSOURI.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., January 18, 1882.

GENERAL: I beg leave to submit herewith a copy of a report, with map and estimates, made by Assistant Engineer S. Waters Fox, on the portion of the Missouri River embraced between Glascow and Arrow

Rock, Mo. The examination upon which this report is based was made in accordance with the requirements of the river and harbor act, approved March 3, 1881, calling for a report on "Missouri River at or near Arrow Rock." The condition of affairs will be fully understood by an examination of the map. Throughout the reach the river is wide and shoal, and cut up into numerous channels, which are constantly shifting and never deep enough for free navigation. In addition to this the incessant bank erosion in the bends is destroying much valuable land, while at the same time bars are forming in front of most of the town landings. This extremely undesirable condition of affairs can only be met by a thorough regulation of the river, which will give permanence to the channel, and prevent further inroads upon the banks. To do this the river must be contracted to a uniform width of about 1,300 feet by suitable permeable dikes, and the old and new shore lines, where exposed to erosion, must be revetted with brush mattresses, as the impossibility of successfully improving short, detached reaches has been amply demonstrated. I have extended the projected work up stream as far as Glasgow, where work is already in progress. In this way a distance of about 15 miles of river is covered. Upon the map is shown approximately the position proposed for the new shore lines.

The plan proposed by Assistant Fox meets with my approval, as also the estimate of $160,000, of which $100,000 could be profitably expended in one fiscal year.

I am, general, very respectfully, your obedient servant,

CHAS. R. SUTER,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. S. WATERS FOX, ASSISTANT ENGINEER.

GLASGOW, MO., *December* 16, 1881.

MAJOR: In accordance with instructions contained in your letter of the 2d instant, I have the honor to hand you herewith a report on the Missouri River from Glasgow, Mo., to Arrow Rock, Mo., together with a project and estimates for the improvement of the same. A tracing of the recent survey between these two points is also submitted. On it are indicated the proposed improvements. Commencing, then, at Glasgow, we see that the channel follows the bluff line on the left bank, to a point a short distance below Bluff Port; from there a long crossing is commenced to the bluffs on the right bank at Saline City. At the medium and lower stages the larger body of water passes down Euphrase Bend. At the higher stages the right-hand chute becomes navigable.

Under these conditions the left bank in Euphrase Bend recedes, and much valuable farming property is destroyed. If allowed to continue a bar will form in front of Saline City, and thus destroy the steamboat landing. Following the right bluff line to about 2,000 feet below Saline City a crossing is begun to left bluffs, striking first about 2,000 feet above Lisbon. Although the destruction to property on this crossing is not so great as above, yet it has been considerable, and will increase if not improved. From Lisbon the channel hugs the bluff line to a point 5,000 feet below: from there is developed Nigger Bend, and much valuable land is washed into the river annually. The situation here is quite similar to that described in Euphrase Bend. The land is more valuable and the extent of bank erosion annually greater. There being no high-water chute, it is exposed directly to the full force of the higher stages. The landing at Arrow Rock is in more imminent danger. The entire reach is amply provided with rock, brush, and timber, conveniently located for construction purposes. With the exception, perhaps, for the crossing from Bluff Port to Saline City, the bluff lines are very favorably located, thus greatly lessening the cost of improvement and insuring its permanence. The proposed shore lines are indicated on the map.

The following table shows the distances between points along the reach measured on the present channel alignment and the distances between the same points on the proposed alignment, viz:

Distances measured.	Old channel, in feet.	Proposed channel, in feet.	Increased length, in feet.
From bridge at Glasgow to station △ 529, Saline City	43,500	45,100	1,600
From station △ 529, Saline City, to station ⑧, Lisbon	16,900	20,500	3,600
From station ⑧ Lisbon, to ▲ 548, Arrow Creek	18,000	23,000	5,000
Total	78,400	88,600	10,200

It is proposed to develop these lines by means of wire-screen dikes supported on piling, frames, or by buoys, depending on location, the development to be followed closely by revetment where necessary.

ESTIMATES.

For convenience, the reach is divided into four divisions:

DIVISION I, FROM GLASGOW BRIDGE TO BLUFF PORT.

Pile revetment, 3,000 feet, at $1.75	$5,250
Wire-screen dikes, tripod supports, 2,700 feet, at 75 cents	2,025
Wire-screen dikes, pile supports, 4,000 feet, at $1.25	5,000
Sand fence, 2,600 feet, at 25 cents	650
Total	12,925
Superintendence and contingencies	3,500
	16,425

DIVISION II, FROM BLUFF PORT TO SALINE CITY.

Pile revetment, 3,500 feet, at $1.75	$6,125
Wire-screen dikes, tripod supports, 6,800 feet, at 75 cents	5,100
Wire-screen dikes, pile supports, 16,000 feet, at $1.10	17,600
Revetment, 20,000 feet, at 80 cents	16,000
Sand fence, 2,200 feet, at 25 cents	550
Buoy dike, 8,500 feet, at 65 cents	5,525
Total	50,900
Superintendence and contingencies	8,200
	59,100

DIVISION III, FROM SALINE CITY TO LISBON.

Revetment, 15,500 feet, at 80 cents	$12,400
Wire-screen dike, tripod supports, 6,700 feet, at 75 cents	5,025
Wire-screen dike, pile supports, 14,400 feet, at $1	14,400
Pile revetment, 2,600 feet, at $1.50	3,900
Sand fence, 2,400 feet, at 25 cents	600
Buoy dike, 4,000 feet, at 65 cents	2,600
Total	38,925
Superintendence and contingencies	6,030
	44,955

DIVISION IV, FROM LISBON TO ARROW ROCK.

Revetment, 12,000 feet, at 80 cents	$9,600
Pile revetment, 3,600 feet, at $1.75	6,300
Wire-screen dikes, tripod supports, 2,300 feet, at 75 cents	1,725
Wire-screen dikes, pile supports, 6,000 feet, at $1.25	7,500
Wire-screen dikes, buoy supports, 14,300 feet, at 65 cents	9,295
Total	34,420
Superintendence and contingencies	5,100
	39,520

SUMMARY.

Division I	$16,[illegible]
Division II	59,[illegible]
Division III	44,[illegible]
Division IV	39,[illegible]
Grand total	160,[illegible]

Of this amount, $100,000 can be profitably expended in one year.

I am, major, with great respect, your obedient servant,

S. WATERS FOX,
United States Assistant Engineer.

S 21.

SURVEY OF NISHNABOTANA RIVER, FROM HAMBURG, IOWA, TO ITS JUNCTION WITH THE MISSOURI.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., March 31, 1882.

GENERAL: I beg leave to submit herewith a map of the Nishnabotana River, from Hamburg to its junction with the Missouri River. The survey was made under my direction, in December, 1881, by Assistant Engineer J. W. Pearl, a copy of whose report is herewith inclosed.

From this report I find that the Nishnabotana, a stream having quite a large drainage basin in the State of Iowa, enters the valley of the Missouri near the town of Hamburg, Iowa. From this point its course lies through the bottom lands along the foot of the east bluffs of the valley. Its course is very tortuous. Prior to 1858 it entered the Missouri 2½ miles below Saint Deroin, Nebr., 26 miles from Hamburg in a direct line, but 63 miles by the river itself. Its channel was deep and narrow, so that floods coming down from the table lands above Hamburg were safely carried off without trouble from overflow.

In 1858 the Missouri River cut through into a bend of the Nishnabotana, 8½ miles by river below Hamburg, and this point then became the mouth. Henceforth there was at high-water a flow from the Missouri and Nishnabotana down the old bed of the latter stream, which was sufficient in amount to carry off the deposits brought in at various points by creeks coming in from the bluffs; both branches generally discharged into the Missouri at the new mouth at low-water. In 1867 a cut-off took place on the Missouri itself, near Peru, Nebr., and the deep bend into which the Nishnabotana discharged was isolated, and at once began to silt up. This process has been going on ever since, till now the deposits in this old channel materially obstruct the discharge from the Nishnabotana at all stages, and, when floods in the two rivers coincide, the whole country about Hamburg is badly inundated.

In 1867, the Kansas City, Saint Joseph and Council Bluffs Railroad closed the head of the old bed of the Nishnabotana and carried a levee across the bottoms to the bluffs. Since that time the old bed has been greatly silted up by the action of the small tributary creeks before alluded to, the deposits in some places being 15 feet in thickness. By this means a series of pools have been formed, in which the water is stagnant for a large part of the year. It has been thought in the neighborhood that the trouble near Hamburg would be relieved by a cut between the two points marked E and E′ on the map, by which the Nishnabotana could be restored to its ancient channel. This no doubt in time would be the case, but, as the old bed is now nearly filled up in many places, it is obvious that for an indefinite period there would be overflows along its entire course, and great damage to property would certainly ensue. Meanwhile the Nishnabotana is working towards deep water in the Missouri, from which it was isolated by the cut-off of 1867. This old cut-off channel is now filling up so rapidly that it will soon be at the level of the adjacent bottom lands, and the waterway, now the channel of the Nishnabotana, will soon be reduced to dimensions suitable for the smaller stream, which will then deepen its bed while at the same time lowering its surface at all stages. When this is once accomplished the present backing up by its larger neighbor will be done away with and the overflows will cease. The result thus obtained will be certain and probably more satisfactory than would be the case by the other plan proposed.

It is proper to state here that no interests of navigation are concerned in this matter; it is purely a question of the local overflows of a small tributary of the Missouri.

I have not made estimates of the cost of opening the old channel, as the plan seems objectionable for many reasons. The natural process of amelioration now going on cannot well be hastened by artificial means.

I am, general, very respectfully, your obedient servant,

CHAS. R. SUTER,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. J. W. PEARL, ASSISTANT ENGINEER.

BROWNVILLE, NEBR., *February* 21, 1882.

MAJOR: I have the honor to submit the following tracing and notes in compliance with instructions of December 2, 1881, to "survey and report on the Nishnabotana River from Hamburg, Iowa, to the Missouri River."

GENERAL DESCRIPTION.

The Nishnabotana River, rising by two main branches, the east and the west, near the center of the west half of the State of Iowa, in Carroll and Crawford counties, flows southwest through a fertile rolling country and enters the Missouri River Valley at Hamburg, Iowa, near the Iowa and Missouri State line.

The river and its tributary streams have an aggregate length of over 800 miles; their drainage basin, covering more than one-twentieth of the State of Iowa, is distributed as follows:

	Square miles.
In Carroll County	72
In Crawford County	180
In Shelby County	432
In Audubon County	432
In Pottawattamie County	576
In Cass County	288
In Mills County	288
In Montgomery County	216
In Page County	144
In Fremont County	432
Total	3,060

Over this area I have estimated that the mean annual rainfall is 28.7 inches and that drainage by the Nishnabotana is 50 per cent. of the downfall. There results: mean annual discharge of the Nishnabotana in cubic feet, 102,014,035,200; mean discharge per second, 3,235 cubic feet.

RECONNAISSANCE.

A reconnaissance of that portion of the river lying in the fertile bottom between the bluffs on either side of the Missouri was made December 5 and 6, and a triangulation station was located on bluff north of Hamburg, by which the upper end of survey can be connected with the triangulation system of the Missouri River survey.

I am indebted to some of the early settlers in the vicinity for the following account of the changes in the condition of the Nishnabotana since 1850.

Previous to 1858, the river, at its extreme westerly bend, about 4 miles below Hamburg, was separated from the Missouri by only a small neck of land, known as "the Narrows," and emptied into the Missouri about 25 miles farther south. The river was in good condition, its banks throughout were stable, and its bed was so firm as to allow of fording at shallow places in low-water. Only occasional overflows were known, and these were not very extensive.

In 1844 there was a general overflow of the Missouri Valley, the water rising higher than in 1881 in this vicinity.

About the year 1858 the encroachments of the Missouri produced a cut-off at the Narrows and formed the section known as the "old bed of the Nishnabotana."

At high stages of water on the Missouri, water from both rivers would be carried over the old bed of the Nishnabotana. A considerable deposit of their sediment was noticed along the upper portion of this old bed and objected to by the people occupying the adjacent land. Along the lower portion of the bed, the overflows from the Missouri were considered a great benefit in distributing and partially removing the accumulation of sediment from tributary streams.

At low stages of water on the Missouri, water from both sections of the Nishnabotana would be discharged at the Narrows.

In 1867 the Kansas City, Saint Joseph and Council Bluffs Railroad Company filled the old bed at K on map, and constructed a levee from J to the bluffs. With its main entrance so effectually barred the old bed has since become a considerable nuisance. The high-water discharge from tributary streams, unaided, being too small to carry their sediment after reaching the old bed, it is deposited in the vicinity of their respective mouths. In many places this accumulation is 15 feet in depth and so unsettled that a pole can easily be pressed downward until it reaches the firm soil of the original bottom below.

Above the mouths of the entering creeks, pools of deep, stagnant water are found. A cross-section at the mouth of the old bed is shown on map at X.

Immediately after the cut-off at the Narrows the river in the vicinity of Hamburg was in excellent condition; it had a free discharge, and overflows were unknown.

In 1867 the condition of the Nishnabotana at Hamburg was again improved by the occurrence of the Peru Cut-off upon the Missouri. On the night of the cut-off the surface of water at the Narrows was noticed to fall 6 feet.

Succeeding stages of high-water upon the Missouri, however, left deposits in its old channel, and I doubt not that the Nishnabotana deposited sediment at all stages. After about eight seasons the accumulation became troublesome, variation between high and low water decreased, low-water being prevented, and occasional overflows caused by obstructions in the stream below the Narrows.

With high-water on the Nishnabotana, and low-water on the Missouri, the induced scour would temporarily improve its condition.

To permanently improve the river, the people in the vicinity of Hamburg would return the river to its old bed by a cut-off from E to E′ on accompanying map.

It is natural and convenient in giving a more detailed description to subdivide this portion of the stream lying in the valley of the Missouri into three sections, as follows:

FROM HAMBURG TO THE NARROWS.

Distance on direct line, 3¼ miles. Leaving Hamburg, the river takes a winding course southward to the State line, 3 miles below. It then bears west of south, and by continued windings secures a channel length of 8¼ miles in traversing the distance of 3¼ miles to the Narrows.

Bridges.—Directly east of Hamburg the river is crossed by a single-span combination highway bridge, the E-street Bridge; 3 miles below, a single-span combination, the State-line Bridge; and 3 miles farther down stream a single-span iron highway bridge is located. The Kansas City, Saint Joseph and Council Bluffs Railroad crosses the river by an iron bridge, two 60-foot spans, about 1 mile above the Narrows.

Surroundings.—At Hamburg, Willow Creek enters from the right bank. At ordinary stages of water this creek partakes of the nature of a bayou. Its width is about 100 feet, and its discharge is small, being supplied by small springs along the eastern bluffs of the Missouri Valley north of Hamburg. One and one-half miles below Willow Creek the drainage from a slough enters from the right bank.

Durfee's Branch, a mere brook, enters from the left bank, about three-fourths of a mile below the State line.

Timber of moderate size, underbrush, and vines occupy the greater portion of the land adjacent to the river and within its bends; the remainder of the field is an open prairie country.

A few small lakes or disconnected sloughs in the vicinity of the present channel give unmistakable evidence of cut-offs, but from the intervening strips of land, and the present stable condition of its banks, it appears that the river has long since abandoned the practice of its erratic neighbor, the Missouri.

FROM THE NARROWS TO PRESENT MOUTH.

Distance direct, 4 miles southwest by south. Distance by water-course through the channel deserted by the Missouri after the Peru cut-off, 5¼ miles.

Passing into the old channel of the Missouri, it takes an easy curve to the southward along the left bank of this old water-way; widens to and maintains an average width of about 350 feet for a distance of 3 miles; then curving to the west, it crosses to the right bank; the width decreases; the current increases rapidly, and slight erosion is noticeable on either shore, until at a point 2 miles below, 2½ miles northeast of Peru, Nebr., and at the lower junction of the old and present channels of the Missouri formed by the Peru cut-off in 1867, the stream flows into the Missouri River with a rippling current, over gumbo bars, at the present mouth of the Nishnabotana.

Farms under a good state of cultivation are located along the left bank of this subdivision; on the right bank, McKissock's Island, with a continuous border of willows rising from the sands deposited by the Missouri at her higher stages.

FROM THE NARROWS TO FORMER MOUTH.

Distance direct, about 23 miles south-southeast. Length of the old bed, from which the waters of the Nishnabotana proper have been confiscated by the Missouri since 1858, 55 miles.

The banks and surroundings of the old bed of the Nishnabotana have much the same appearance as the section lying between Hamburg and the Narrows described above. From the narrows it turns eastward to the bluffs, and with winding course follows their general direction for a distance of 16 miles, then angling to the west of south, it enters the Missouri about 2½ miles below Saint Deroin, Nebr.

SURVEY.

For a general discussion of the subject a general survey of the river below Hamburg would be necessary. The means provided were too meager for the complete work, so the survey was confined to the stream from Hamburg to the Missouri and such observations upon the bed and old Missouri channel as were easily obtainable.

Levels and slope.—A level party, consisting of levelman, rodman, and axman, started from Hamburg December 10, 1881, with datum 100 feet below datum of city levels; they ran a line to the E-street Bridge, thence along the river to the present mouth, and returning finished check levels to Hamburg December 31, 1881. Bench-marks were established and water surface taken en route and on the old bed at E' on map. A water gauge located at the E-street Bridge, and read morning and evening from December 10 to December 31, shows a fluctuation of 1.55 feet.

The levels show a fall of 9.10 feet from the E-street Bridge to the Missouri, the slope being irregularly distributed, as shown in profile on map.

Discharge observations.—Left Brownville, Nebr., December 10, 1881, with skiff, two oarsmen, and the necessary instruments, and arrived at the mouth of the Nishnabotana at 2 p. m. Passing up the river, a water gauge was placed about 2 miles from the mouth, where the slacking of the current is quite noticeable; another just below the Kansas City, Saint Joseph and Council Bluffs Railroad Bridge, and the section for observations located about 1 mile below the E-street Bridge at B on map.

The sections were carefully surveyed in this vicinity; three graduated wires were carried across the stream, drawn taut, and fastened in position 100 feet apart and at right angles to the current. In taking the velocity of water the level party assisted; common double floats connected by a small cord were used, and the horizontal curves for surface, and at depths of 5, 7½, 10, 12½ and 15 feet were carefully determined. The floats were dropped from skiff about 100 feet above the upper wire, and three men, one stationed in line with each wire with flag and chronograph, observed crossing under each wire. Work was completed and return made to Brownville December 14, 1881.

In calculations upon the discharge the cross-section under the middle wire was used; from the mean velocity at various points horizontal and vertical curves were plotted on a large scale, and the summation of discharge for each foot of depth gives:

Low-water discharge, per second	cubic feet..	1,673
Area of cross-section	square feet..	1,299
Breadth of cross-section	feet..	112.5
Mean depth of cross section	feet..	11.5
Maximum velocity observed, per second	feet..	2.0
Mean velocity observed, per second	feet..	1.3

Mean velocity equals 80.5 per cent. of maximum velocity.

Shore lines.—This work was delayed until January 4, 1882, in expectation of a formation of ice, which would greatly facilitate operations; a party was then organized, and commencing at the mouth, a chain, transit, and stadia line was carried up the river to the point where it enters the old Missouri channel. Here it was found advisable to continue the work with transit and stadia only. The main line was carried up along the Nishnabotana to a point about 1 mile above Hamburg; a branch line run up the old channel of the Missouri for a distance of 2 miles, and a second branch taken down the old Nishnabotana bed a distance of 1¼ miles, to a point where it takes its course to the southward along the bluffs which limit the valley of the Missouri on the east.

Several other lines were run in at various places and connected with the main for checks on the work, and the location of sloughs, creeks, &c.

The work was connected with and checked by angles from various stations to the triangulation station erected on the bluffs northwest of Hamburg. All was completed January 13, 1882.

Map.—The cross-sections exhibited on the map are characteristic of the conditions of the river in the localities indicated.

In the profile, the full line represents the surface of water under the present conditions at low-stage from the E-street Bridge to the mouth, and thence by the Missouri to the former mouth, represented at X; broken dotted line, mean high-water under present condition; broken lines show the fall and slope by the old bed and desired cut-off; broken dotted lines through P and Q, the probable surface at low-water, and through S the probable surface at high-water by old bed or desired cut-off; dotted line through R, the probable surface of water at the Narrows at low stage with the Missouri running in its old channel.

DISCUSSION.

Interested parties assert that their mark of low-water on the Nishnabotana in the vicinity of Hamburg, Iowa, previous to 1858, is now 13 feet below the lowest water of recent years. This seems large.

Land owners along the old bed of the river are about equally divided in sentiment for and against the reopening of the old course. All that is desired by the citizens of Hamburg and vicinity is freedom from overflows and partially stagnant water.

In connection with the improvement of the Missouri, it is desirable to hold the Nishnabotana to its present channel, that it may assist in any effort to reclaim the old Linden Bend.

In reclaiming its old course the river must scour a channel-way 55 miles long, which at many places is nearly filled by the detrital accumulation of the past twenty years.

In the present channel, if freed from the evil influences of the Missouri at its higher stages, the Nishnabotana can, by removing the sediment from a channel-way 5 miles in length, secure its best possible outlet.

The periodic deposits of sediment in the upper portion of the old channel of the Missouri by overflows, assisted by drifting sand, will, in time, raise this section above the high-water line, unless artificial means be used to prevent it. The flood of 1881 did much to ameliorate the evil influences of the Missouri.

CONCLUSIONS.

Litigation can be avoided, freedom from floods and a free low-water discharge can best be obtained, and the interest of probable navigation promoted, by allowing nature to take her course.

Very respectfully, your obedient servant,

J. W. PEARL,
Assistant Engineer.

Maj. CHAS. R. SUTER,
Corps of Engineers, U. S. A.

APPENDIX T.

IMPROVEMENT OF MISSOURI RIVER ABOVE MOUTH OF YELLOWSTONE—IMPROVEMENT OF YELLOWSTONE RIVER.

REPORT OF CAPTAIN EDWARD MAGUIRE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882.

IMPROVEMENTS.

1. **Missouri River above mouth of Yellowstone, Montana.**
2. **Yellowstone River, Montana and Dakota.**

UNITED STATES ENGINEER OFFICE,
Saint Paul, Minn., July 8, 1882.

GENERAL: I have the honor to submit herewith my annual reports upon the works of river improvements in my charge, for the fiscal year ending June 30, 1882.

Very respectfully, your obedient servant,

EDWD. MAGUIRE,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

T 1.

IMPROVEMENT OF THE MISSOURI RIVER ABOVE THE MOUTH OF THE YELLOWSTONE.

The work of last season was confined to the river below Benton.

On June 29, lumber for six barges having been previously shipped, an overseer with twelve men was sent to Gallatin Rapids, arriving there July 14; the old boats were repaired and as much work done on the barges as was permitted by the amount of lumber which had been delivered. The removal of rock from Gallatin Rapids was commenced August 8, and continued until August 29. There were twenty-six blasts exploded and 269 cubic yards of rock taken out. Most of the rock was used in the construction of a dam, the effect of which was to divert the water and assist materially in running the channel. Owing to the low stage of water, a large proportion of the barge lumber had been left at Grand Island, and seeing no prospect of its being brought to him, the overseer moved the party to the latter place and resumed barge-building September 2.

The main party, consisting of Assistant Engineers H. E. Stevens and W. H. Wood, one recorder, one overseer, and sixty-five laborers, including the steamboat crew, left Bismarck August 22.

The work of previous seasons was found to be in the following condition:

The break in the Grand Island Chute dam had not increased; the chute was nearly filled with gravel, and no repairs or other work was necessary. The training dam on the bar above Grand Island constituted the crest of a large bar which had formed, and is so revetted with gravel above and below that its permanency is assured. These dams have straightened and deepened the channel over the upper shoal from a crooked one of 2.4 feet depth to an easy one of 2.9 feet depth. An increased depth may confidently be expected. Over the bar below Grand Island there is a greatly improved channel, with a least depth of 3.2 feet.

At Cow Island, Snake Point, Little Dog, Lone Pine, and Bear Rapids, and Chimney Bend, the dams and channel are in good condition.

The lower reef at Castle Bluff has not scoured, and additional work is needed at that point.

There is good water over McGarry's Bar, but the dam should be extended.

The dam at Snake Point should be extended.

At Dauphin's Rapids the dam was repaired with 875 cubic yards of stone, part of which was quarried and the remainder taken from the river by grabs.

At Grand Island 371 cubic yards of stone were quarried and placed in the dam at the lower point of the island.

Surveys were made during the season at the following named localities: Grand Island, Armell's Island, Hawley Island, Trover Shoal, Buffalo Shoal, and McGonigal's Shoal.

A party consisting of Assistant Engineer Stevens and forty-five employés left Bismarck with the steamboat May 5, 1882. Up to June 21, the last date of receipt of information, the following work had been done, viz: The bars at Pablos and Kips' rapids had been raked for a length of 1,000 feet and a width of from 100 to 200 feet, and 1,670 cubic yards of stone had been quarried and delivered at the various localities where needed for dams.

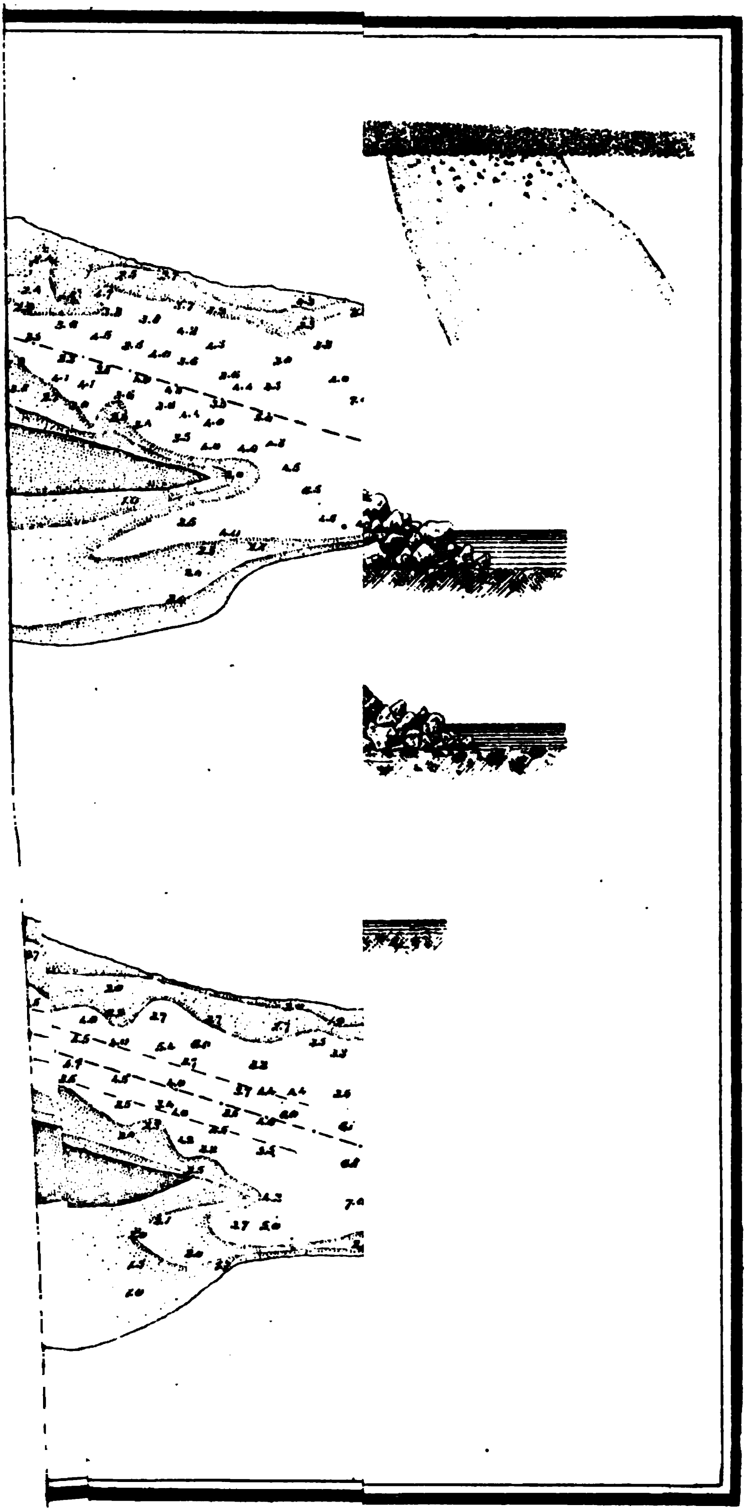
It is proposed to send, as soon as practicable, another party, under charge of Assistant Engineer Wood, to join that now in the field. The work of the present season will consist in completing the removal of rock from the channel at Gallatin Rapids, in strengthening the dam at Dauphin's Rapids, and in completing the dams at Snake Point, McGarry's Bar, and at the lower end of Grand Island. It is also expected that dams will be built at Hawley Island, Trover, and Buffalo Shoals, and Castle Bluff.

Money statement.

July 1, 1881, amount available		$46,514 12
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$38,489 19	
July 1, 1882, outstanding liabilities	6,954 94	
		45,444 13
July 1, 1882, amount available		1,069 99
Amount that can be profitably expended in fiscal year ending June 30, 1884		150,000 00

COMMERCIAL STATISTICS.

Five lines of steamboats make their headquarters at Bismarck, Dak., and from twenty to thirty boats ply between that town and points on the Missouri River, making during the season of navigation from one hundred and fifty to one hundred and



enty-five trips. The business for 1881 was in excess of that for any previous year. ere were twenty-one boats employed, the largest being the Dacotah, with a freight acity of 1,400 tons, and the smallest with a freight capacity of 250 tons. These ts carried into Montana 27,560,000 pounds of private and 7,200,000 pounds of govment freight, making a total of 34,760,000 pounds, valued at $5,214,000.

n addition, there were transported 1,300 passengers, 2,400 Indians, 1,800 head of ses and cattle, and 600 head of sheep. The exports, as far as learned, were as fol's: 23,000 buffalo hides, valued at $37,500; 180 tons wool, valued at $90,000; 253,750 ınds of hides, pelts, &c., valued at about $76,125; and also an unestimated quan- of furs and wolf-skins.

he steamboat owners estimate that the business this season will exceed that of last r. The rapid settlement of the country tributary to Benton and the Judith Basin l call for large shipments by river in the future.

My thanks are due to Assistant Engineers Stevens and Wood for se attention to and excellent execution of the work assigned to them.

T 2.

IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND DAKOTA.

The work was carried on by two parties, which left Saint Paul July , 1881.

The first party consisted of one recorder, one overseer, one sub-overer, and twenty-three laborers; Assistant Engineer F. M. Towar in arge. This party was employed in building a dam at Buffalo Rapids, d in blasting and removing a portion of the ledges at Wolf and Baker's pids.

The dam was constructed of stone, gravel, and brush fascines. The tter were made principally of willow intermingled with small cottonood, were from 18 to 22 feet long, and from 1 foot to 14 inches in diamer. The stone varied in size from that of a cobblestone to that which wo men could conveniently handle. Those on the outer end of the dam ntained from 5 or 6 cubic feet to a yard each. The gravel was such s could be obtained in the immediate vicinity of the dam. The shore rotection was made by shoveling away the bank for a length of 50 feet nd width of 20 feet, and in this trench laying fascines perpendicular the stream. Each fascine was firmly staked. On top of the mattress hus formed was placed a layer of about 6 inches of gravel, surmounted y a layer of stone about 1 foot thick, and this in turn covered with fine ravel. Finally, the whole was overlayed with cobblestones, well rammed. he dam proper was carried above low-water level by alternate layers f fascines and stone and gravel. The fascines were made into mats bout 14 feet long, sunk with a load of stone, and staked in position. hey were then covered with a layer of stone about a foot thick. Each ayer was carried out the full length of the dam before beginning the ext one. The butts of the second layer were placed 6 feet up stream rom those of the first, and those of the third layer 3 feet up stream from hose of the second. The dam as thus constructed was covered on its ace and crest with gravel to a depth of about 2 feet for 375 feet from he shore. Beyond that distance rock alone was used for the covering. he following is a summary of the work done:

	Feet.
otal length of dam and shore protection	565
umber of fascines made and placed	1,196
umber of cubic yards rock placed	1,323
umber of cubic yards gravel placed	553
umber of cubic yards rock removed from channel	36

The work of blasting and removing rock at Wolf Rapids was co menced August 9 and continued until October 5, at which time t party removed to and commenced work on Baker's Rapids. The wo was continued at this point until November 3, when the party return to Saint Paul.

The following is the amount of work done at the last-named points

WOLF RAPIDS.

Number of holes drilled	1
Number of blasts exploded	3
Number cubic yards rock removed	2

BAKER'S RAPIDS.

Number holes drilled	
Number blasts exploded	1
Number cubic yards rock removed	1

The second party consisted of one recorder, one overseer, one sub-ove seer, and forty-three laborers; Assistant Engineer J. J. Durage in charg This party was employed in building dams at Edgerly's Island and Glendive.

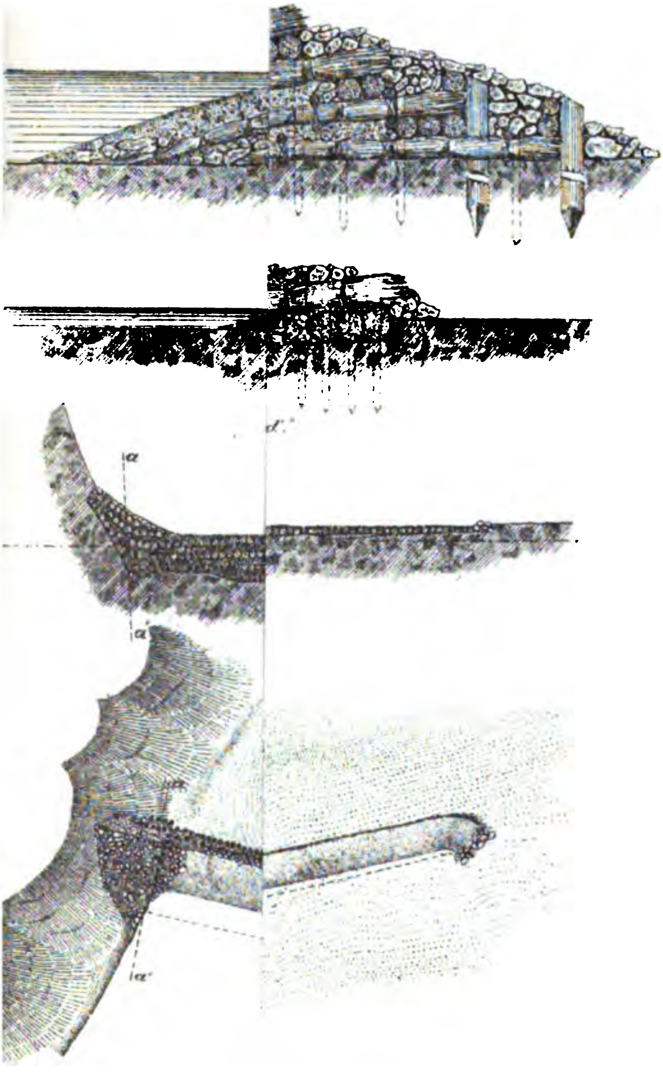
The necessary boats were built at Buffalo Rapids. The party w delayed in its work by the willful and inexcusable failure of a firm Miles City to supply the lumber which they had contracted to furni several weeks previous, and which they assured me they had on hand. was only through the kindness of Lieut. Col. J. N. G. Whistler and Ca F. H. Hathaway, at Fort Keogh, that lumber could be obtained. T following boats were built, viz: One scow, 53 feet by 21 feet by 3½ fe with pile-driver of 30 feet leaders and 2,200 pounds hammer; two sto barges, 65 feet by 16 feet by 3 feet 8 inches.

Two chutes were closed at Edgerly's Island by dams, the constru tion of which was commenced September 3. They were constructed piles, fascines, stone, and gravel. The fascines were made of cotto wood saplings and tree-tops, together with such willow brush as cou be obtained. The piles were large cottonwood trees, peeled. Th proved to be very good piles, strong, straight, brooming but little driving, and hardening in water.

The rock ballast consisted of bowlders found imbedded in the ba They consist of a large number of fossil shells, cemented together an argillaceous limestone, and are quite hard and heavy. Some sa stone picked up in the coulées was also used. Cobble-stones and gra were also used as ballast. They were found in strata in the bank.

The piles were driven only in the 2-foot curve and all around the sh protection. Two rows were driven to form the back of the dam. T were driven only 7 to 10 feet, the latter depth very seldom. The b tom was hard, and in some places fifteen blows of the hammer fai to drive the pile even an inch after reaching a depth of 6 feet. T double row was cut off at the level of the ballast of the lowest la of fascines.

The fascines were from 18 to 22 feet long, and of about 1 foot mid diameter, well choked every 2 feet, and bound with lath-yarn. Th were formed generally into mats of from seven to twenty fascines, b tween cottonwood binders 4 feet apart, and properly secured by ro and lath-yarn. Each fascine, whether laid singly or in a mat, was he in position by cottonwood stakes 3 to 4 feet long and 3 to 4 inches diameter. In the immersed section only mats were used. The fi layer was laid close to the piling. To secure the gravel cross-binde


a''
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a'
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a'

re placed, three in a row. They were staked down and secured with pe. The middle layer was put in in a similar manner, and the third top layer was staked down and ballasted to the depth of about 1 ot. The whole dam was faced with gravel.

UPPER DAM.

tal length of dam and shore protection	feet..	1,192
ight of dam	do...	1.75 to 5.4
idth of crest	do...	17 to 28
idth of base	do...	21 to 45
ight of shore protection	do...	10.5
mber fascines made and laid		2,300
mber stakes cut and driven		6,020
mber cubic yards rock placed		1,987
mber cubic yards gravel placed		817
mber piles cut and driven		329

Effects of the dam.—About one-fourth of the whole volume of the river, hich formerly flowed through the chute, was turned into the main annel, raising the water at the dam 1.3 feet. The permanent gauge low indicated an increase in depth of 2.5 inches.

The construction of the lower dam was more difficult. The river here as divided into three chutes, the middle one of which was of slight nsequence and was easily closed. The left chute made a very sharp rn, and the water was discharged through it over a gravel ridge and ith great velocity.

LOWER DAM.

tal length of dam and shore protection	feet..	860
eight of dam at deepest portion	do...	5 74
idth of base	do...	30 to 40
idth of crest	do...	18 to 22
idth of shore projection	do...	55 to 25
mber facines made and laid		1,422
mber stakes cut and driven		3,144
mber piles cut and driven		173
mber cubic yards rock placed		863
mber cubic yards gravel placed		447

This dam was constructed similarly to the upper one, but the direction f the lower one is nearly parallel to the axis of the river. The shore rotections of both were countersunk in the bank and carried to such a eight and length as to be an adequate protection against the scour of igh-water. On the bars the dams were extended to the largest and ost compact gravel and fanned at the ends.

Effects of lower dam.—While the dam was in process of construction e water rose uniformly with the filling, backing up and diverting the ater towards the right bank. The deepest water in the channel before e dam was built was 2.2 feet. As soon as the dam reached a height f about 2 feet above the original water level the water began to fall pidly until it reached a stationary stage of about 9 inches above the riginal level. It cut the shoal, deepening and widening the main chan-el. The depth on the shoal at the time the party left the work, that , time of lowest water, was 3 to 4 feet. The material scoured out was rried about 1,200 feet downstream and deposited in the eddy at the nd of the bar on the left, causing an extension of the bar. The effect f the two dams was to increase the depth between them by 0.55 foot.

The work at this point completed, the party moved to the head of atie's Island, opposite Glendive. The left chute here was closed. The velocity of the water in this chute was not great, but there was a dep in the middle of the channel of 7 feet. The left bank is about 24 fe high and the point of Katie's Island is a bar. Brush and gravel w found to be plentiful, but rock was scarce. The method of piling f this dam differed from that of the Edgerly dams. As the piles cou be driven only 8 feet, the pressure of the water would bend and loose them. To get rid of as much of this pressure as possible the dam w divided into sections, each alternate one of which was filled up to th level of the water. The piling in these sections was driven at an ang and in the form of reversed ice-breakers. Logs were then laid betwee these sections, so as to form a sort of apron to relieve somewhat th piles of the other sections, which were driven behind these logs. Th latter sections were then closed, filling in uniformly from the bottom i all of them at a time. The island end of the dam had to be counte sunk about 2 feet and carried out 110 feet to obtain a good anchorag The mode of construction can be better understood from the drawing appended.

Total length of dam and shore protection	feet..	5
Height of dam in deepest water	do...	
Width of base	do...	25 to
Number facines made and laid		1,3
Number stakes cut and driven		2,1
Number piles cut and driven		1
Number cubic yards rock placed		4
Number cubic yards gravel placed		3

Owing to heavily running ice, the work was discontinued Novembe 16, and the party returned to Saint Paul.

All of the dams built by these parties have withstood the action the ice and spring freshets, and are reported by the watchmen as i good condition. They accomplished the purpose for which they we intended.

Money statement.

July 1, 1881, amount available		$27,655
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$24,808 39	
July 1, 1882, outstanding liabilities	731 50	
		25,539
July 1, 1882, amount available		2,115
Amount appropriated by act passed August 2, 1882		20,00
Amount available for fiscal year ending June 30, 1883		22,115
Amount that can be profitably expended in fiscal year ending June 30, 1884.		100,00

COMMERCIAL STATISTICS.

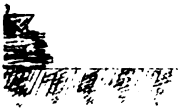
Five lines of steamers make their headquarters at Bismarck, Dak and from twenty to thirty boats ply between this town and points o the Missouri and Yellowstone, making during the season of navigatio from one hundred and fifty to one hundred and seventy-five trips.

The steamboat business for 1881 was greatly in excess of any previou year. There were twenty-one boats employed, the largest being th Dacotah, with a freight capacity of 1,400 tons, and the smallest th General Tompkins, with a freight capacity of 250 tons.

The freight carried up the Yellowstone River amounted to 8,420,00 pounds, of an estimated value of $1,263,000. The exports were pri

Yellowstone River

falo Rapids



STONE RIVER
1881

lf Rapids

le 1: 4800

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es of Profile
ntal 1: 6000
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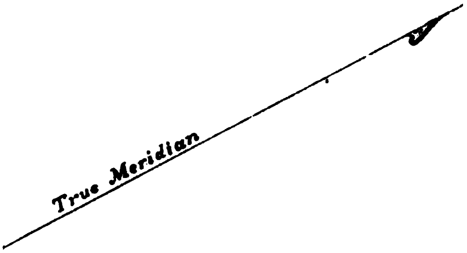
stage of water 0'025 below the low

Edw Maguire
Capt of Eng. U.S.A.



STONE RIVER

1881

er Rapids

Scale 1:4800

gs were taken at low water
he stage of Oct. 23 1878

Edw Maguire

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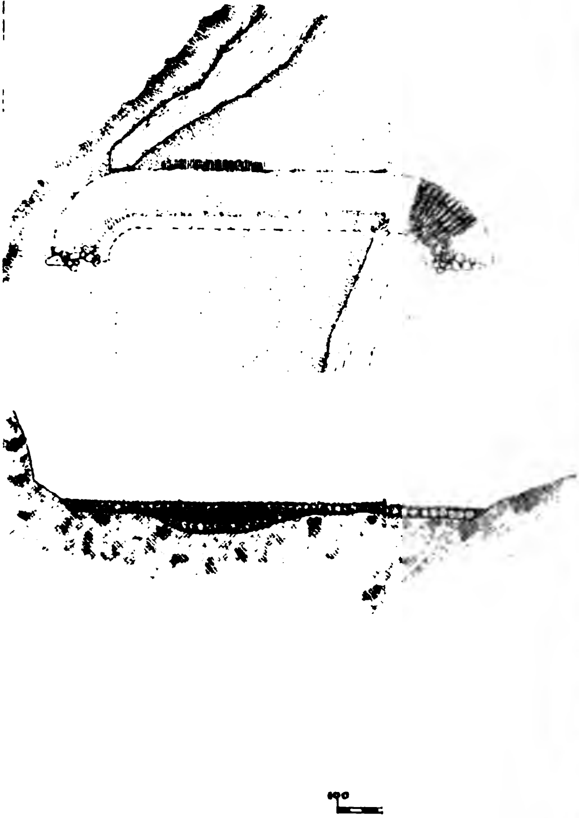
100

pally hides, furs, and skins. There were shipped 93,000 buffalo robes, a value of 232,500, and about 263,000 pounds of hides, valued at 5,533, besides a quantity of furs and wolf-skins. The above values e those on the river bank.

The Northern Pacific Railroad has tapped the Yellowstone Valley at lendive, and it is hardly possible that there will be any freight carried n the river above Glendive as long as the railroad freight rates remain easonable. But from Glendive to the mouth is a stretch of river which ay be made very useful as a line of transportation for Benton and ther Upper Montana freight. The long up river haul of 303 miles rom Bismarck to Buford would thus be saved by a down-river haul of bout 100 miles. Hence it is proposed to confine the work of the coming eason to that portion of the river. The work will consist in completing he dam at Katie's Island by raising it a foot higher, removing rocks nd snags from the channel at the foot of Katie's Island, constructing ams at Glendive Shoal and Stanly's Shoals, and removing the few ocks and snags which are to be found between those points.

There are several other places which need improvement, particularly he mouth. There are in the lower reach a number of snags and overanging trees which should be removed. I am confident that a channel t least 3½ feet deep can be obtained and maintained during the season f navigation.

I am indebted to Assistant Engineers Towar and Durage for close ttention to, and conscientious and skillful performance of, the duties ssigned to them.

APPENDIX U.

MPROVEMENT OF THE NAVIGATION OF THE MISSISSIPPI RIVER BETWEEN SAINT PAUL AND THE MOUTH OF THE ILLINOIS, INCLUDING IMPROVEMENTS AT SPECIAL LOCALITIES BETWEEN THOSE POINTS—IMPROVEMENT OF GALENA RIVER AND HARBOR, ILLINOIS—IMPROVEMENT OF CUIVRE RIVER, MISSOURI—OPERATING DES MOINES RAPIDS CANAL.

REPORT OF MAJOR ALEXANDER MACKENZIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Upper Mississippi River, operations of snag-boat, &c.
2. Mississippi River from Saint Paul to the Des Moines Rapids.
3. Mississippi River from Des Moines Rapids to the mouth of Illinois River.
4 Removing sand bar in Mississippi River opposite Guttenberg, Iowa.
5. Removal of bar in Mississippi River opposite Dubuque, Iowa.
6. Rock Island Rapids, Mississippi River.
7. Harbor at Rock Island, Illinois.
8. Mississippi River at Andalusia, Ill.
9. Harbor at Muscatine, Iowa.
10. Harbor at Fort Madison, Iowa.
11. Des Moines Rapids.
12. Des Moines Rapids Canal.
13. Mississippi River near Alexandria, Mo.
14. Mississippi River at Quincy, Ill.
15. Quincy Bay, Ill.
16. Mississippi River at Hannibal, Mo.
17. Mississippi River at Louisiana, Mo.
18. Galena River and Harbor, Ill.
19. Cuivre River, Missouri.
20. Transportation and distribution of rations and supplies to the sufferers by overflow of Mississippi River.

EXAMINATIONS AND SURVEYS.

1. Harbor of refuge in Lake Pepin, at Stockholm, Wis., and Lake City, Minn.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 12, 1882.

GENERAL: I have the honor to transmit herewith the annual reports of operations under my charge during the fiscal year ending June 30, 1882.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

U 1.

OPERATIONS OF SNAG-BOAT IN IMPROVEMENT OF UPPER MISSISSI RIVER.

The snag-boat General Barnard was employed during a portion of
past year in removing obstructions and assisting navigation betwe
Saint Paul and the mouth of Missouri River. Similar service was a
performed by this boat for a short time below Saint Louis under ord
of Maj. O. H. Ernst, Corps of Engineers. Between October 10 and
1881, she was employed on an inspection trip from Saint Louis to
mouth of Red River with the Mississippi River Commission on boa
and on March 16, 1882, the boat, in accordance with instructions
ceived, was placed under orders of Colonel Beckwith, Subsistence
partment, for duty in connection with supplying rations to suffer
from overflow on Lower Mississippi River. The details of the w
above mentioned, together with statistics and other valuable infor
tion, will be found in the appended report of Assistant C. W. Durh

Arrangements were made early in January, 1882, with Howard
Co., of Jeffersonville, Ind., for constructing the light-draught stea
authorized by act of March 3, 1881. This boat will be completed by
middle of July.

It is proposed in the future to use the General Barnard for the hea
snagging work of the district, and when this is accomplished to repl
her services with those of the smaller and lighter-draught boat.
service upon which the snag-boats are engaged is one of great imp
tance, and the interests of navigation can be best served by permitti
them to perfom a full season's work. The estimate submitted is ba
on the cost of operating and repairs, and cannot be materially redu
without seriously interfering with the efficiency of the boats. I wo
respectfully recommend for the maintenance of the snag-boats for fis
year ending June 30, 1884, an appropriation of $30,000.

My annual report of last year contained references to several subje
of great importance in connection with the navigation of the Upp
Mississippi. The most important of these subjects related to the furnis
ing of additional facilities for passing the various bridges in safety.
special report on this subject was rendered March 9, 1882, and is print
as House Ex. Doc. No. 136, Forty-seventh Congress, first session.
understand Congress has taken action on it during the present sessi

The deposit of sawdust and mill refuse in the Mississippi River
continued during the past year. Evidence is abundant that this pr
tice is injurious to the interests of navigation, and should be prohibit

The condition of the Upper Mississppi during the past year has be
a remarkable one, and a flood-stage has prevailed almost continuous
Excepting a very brief period during the summer navigation of
river has only been interfered with by the difficulty of finding landi
points. During the very short time the water was low enough to
velop a low-water channel no difficulty was experienced at any poi
where improvements have been made.

Throughout the year the largest class of boats were able to reach Sai
Paul, except for about two weeks, when a bar at Pine Bend, 10 mil
below, interfered with their progress.

ABSTRACT OF APPROPRIATIONS.

By act approved March 2, 1867	$96,
By allotment from appropriation of July 25, 1868	26,
By act approved July 11, 1870	36,

By act approved March 3, 1871	42,000
By act approved June 10, 1872	42,000
By act approved March 3, 1873	25,000
By act approved June 23, 1874	25,000
By act approved March 3, 1875	25,000
By act approved August 14, 1876	30,000
By act approved June 18, 1878	41,500
By act approved March 3, 1879	20,000
By act approved June 14, 1880	8,000
By act approved March 3, 1881	25,000
	441,500

Money statement.

July 1, 1881, amount available		$28,346 59
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$6,971 65	
July 1, 1882, outstanding liabilities	20,000 00	
		26,971 65
July 1, 1882, amount available		1,374 94
Amount appropriated by act passed August 2, 1882		25,000 00
Amount available for fiscal year ending June 30, 1883		26,374 94
Amount that can be profitably expended in fiscal year ending June 30, 1884.		30,000 00

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1882.

MAJOR: I have the honor to present my annual report on improving Upper Mississippi River for the fiscal year ending June 30, 1882, together with some statistics of commerce and navigation.

OPERATIONS OF SNAG-BOAT GENERAL BARNARD.

During April and May, 1881, the General Barnard was put in readiness for service, and on May 21 began her season's work, as mentioned in last year's report.

From July 1 to September 27 she was engaged between Saint Paul and the mouth of the Missouri River in removing snags, impending trees, wrecks, &c., assisting steamboats, establishing water-gauges, buoys, and channel-marks, making surveys and reconnaissances, transporting government property, and rendering occasional service to the works of permanent improvement.

From September 1 to October 10 she was employed under orders of Maj. O. H. Ernst, Corps of Engineers, in removing snags and obstructions from the river along the bank below Carroll's Island, about 18 miles below Saint Louis, with the object of affording a clear shore for laying brush protections.

Between October 10 and 25 made an inspection trip from Saint Louis to the mouth of Red River and return, under orders of the Mississippi River Commission.

Laid up in the canal at Keokuk November 22.

During the season of 1881 good service in removing snags and impending trees was performed at or near several localities, among which may be mentioned Cuivre River, Turtle Island, Carroll's Island, Buffalo Chute, Mosier's Island, Westport Chute, Cassville Slough, Crooked Slough, Redwing, Frenchman's Bar, and between Saint Paul and Hastings.

In September a survey was made of the bar below Dixon's Landing.

SUMMARY OF OPERATIONS OF UNITED STATES STEAMER GENERAL BARNARD, SEASON OF 1881, IN UPPER MISSISSIPPI AND CUIVRE RIVERS.

Snags removed	520
Leaning trees pulled back	73
Leaning trees felled	14,705
Steamboats assisted	3
Wrecks destroyed	2
Miles of survey lines	2
Soundings recorded	1,533
Miles run	6,554

On March 16, 1882, the General Barna d left Keokuk for Saint Louis, where she ar- rived on the 18th. She was then put under orders of General Amos Beckwith, Com- missary Department, for the purpose of transporting supplies for the relief of overflow sufferers on the Lower Mississippi River. She was engaged in this service until April 20, at which date she was laid up in the canal at Keokuk, Iowa.

On May 16 she was taken to Dubuque, Iowa, for repairs, which are now nearly com- pleted.

The river and harbor act of March 3, 1881, under the head of "Improving Upper Mississippi River," provided funds for building a light-draught steamboat. Plans and specifications were prepared and submitted by you to the Chief of Engineers on Decem- ber 14, 1881, and authority was given, December 20, to solicit proposals from reliable steamboat-builders on the Ohio and Mississippi rivers. The work was assigned to How- ard & Company, of Jeffersonville, Ind., who made the lowest offer, at a price of $18,75 The boat, which is of wood, is now nearly completed. Her principal dimensions are a follows: Length on deck, 140 feet; beam, 28 feet; hold 4 feet; two non-condensing en- gines, with cylinders 14¼ inches diameter, by 6 feet stroke of piston; three Otis steel boilers, 40-inch shell, 20 feet long, with five 9-inch return-flues in each.

RIVER NOTES.

During the season of 1881 the river was at a good boating stage, except for a sho time during August, and the largest boats were unable to reach Saint Paul only durin a period of about two weeks. In 1882 the river has continued high until the presen time, and no trouble has as yet been experienced by navigators form lack of water.

I give a list of channel-depths on some of the worst bars at the lowest-water period of 1881:

Frenchman's, 4 feet; Pig's Eye, 3 feet 3 inches; Red Rock, 4 feet 6 inches; Newpor 4 feet 6 inches; Merrimac, 4 feet; Robinson's, 4 feet 6 inches; Island No. 10, 3 feet Pine Bend, 5 feet; Gray Cloud, 4 feet; Prescott, 3 feet 6 inches; Reed's, 4 feet; Wa basha, 4 feet; Crat's Island, 4 feet; Teepeeota Point, 4 feet; Beef Slough, 4 feet Rollingstone, 4 feet; Pine Island, 4 feet; Bellevue, 4 feet 6 inches; Johnson's Islan 4 feet; Foot Rush Chute, 4 feet 6 inches; below Burlington, 3 feet 6 inches; Skun River, 4 feet; Montrose, 4 feet; Tully Island, 4 feet 6 inches; Smoots's, 3 feet 3 inche Wyaconda, 4 feet 6 inches; Gilbert's, 4 feet 6 inches; Dixon's, 3 feet 6 inches.

STATISTICS OF COMMERCE AND NAVIGATION.

Lumber.—The most important business interest on the Upper Mississippi and it principal tributaries is the lumber trade, which gives employment to great numbe of men, and upwards of one hundred steamboats, which are used in guiding and pr pelling rafts. Between the mouth of the Chippewa and Saint Louis there are eight mills on the main river, with an annual day-sawing capacity of 800,000,000 feet, em ploying some 16,000 men, and representing about $16,000,000 capital.

On the Upper Mississippi and its tributaries, the Saint Croix, Chippewa, Wisconsi and Black, there are about two hundred mills engaged in the manufacture of lumbe the greater part of which product is floated into the former stream.

The following table shows the lumber product of the Mississippi River and tribu taries from 1877 to 1881, inclusive:

Comparative statement of the white pine lumber product for five years.

Locality.	1881.	1880.	1879.	1878.	1877.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Mississippi	952,000,000	789,805,000	614,641,000	418,446,000	456,840,
Saint Croix	123,000,000	111,380,000	84,230,000	61,941,000	53,341,
Chippewa	475,000,000	350,632,000	243,665,000	154,119,000	157,046,
Black	112,000,000	123,230,000	73,500,000	62,252,000	49,250,
Total, Mississippi Valley	1,662,000,000	1,375,047,000	1,016,036,000	696,758,000	716,477,

In addition to the above amount of lumber, there were manufactured in 1881 abou 500,000,000 shingles and 150,000,000 lath. The product of the Wisconsin River is omit- ted from the above statement, inasmuch as nearly all the lumber made on that rive is shipped by rail.

STEAMBOATS AND FREIGHT.

The principal steamboat lines on the Upper Mississippi River are the Saint Louis and Saint Paul Packet Company and the Diamond Jo Line. There are also some independent boats, carrying freight and passengers. The total amount of freight carried by these two lines was, in 1881, 380,000 tons; in 1880, 567,180 tons; in 1879, 411,862 tons.

Passengers carried by above lines in 1881, 43,700.

Statement of amount of freight received and shipped from Saint Louis by the Upper Mississippi River for five years.

	1881.	1880.	1879.	1878.	1877.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Received	190,815	226,095	221,285	174,065	136,715
Shipped	54,295	55,260	66,990	67,320	68,565
Total carried	245,110	281,355	288,275	241,385	205,280

Movement in flour and grain by Upper Mississippi boats in 1881.

Saint Louis.	Flour.	Wheat.	Corn.	Oats.	Rye.	Barley.
	Barrels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Receipts	52,137	444,686	698,630	1,697,834	44,231	246,359
Shipments	18,210	9,955	8,158	7,114	574	5,710
Total movement	70,347	454,641	706,788	1,704,948	44,805	252,069

The following table affords a comparative view of the relative amount of navigation at various localities on the Upper Mississippi River for the last three years:

Locality of bridge.	Steamboats.			Barges.			Rafts.		
	1881.	1880.	1879.	1881.	1880.	1879.	1881.	1880.	1879.
Hastings	1,843	2,065	2,468	563	448	397	14	29	54
Winona	4,739	4,593	3,760	575	883	1,362	1,777	1,392	1,889
La Crosse	4,461	3,539	2,827	448	505	779	1,608	1,278	1,077
Dubuque*	4,710	3,625	2,894	666	878	....	1,380	1,375	801
Sabula†	2,317		....	653	....	....	958	....	....
Clinton	3,167	3,253	2,643	721	1,020	996	‡370	‡646	‡590
Rock Island	2,711	2,664	2,514	449	642	750	953	782	571
Burlington	2,312	1,871	1,251	623	694	662	523	522	367
Keokuk	2,746	1,868	1,562	1,922	890	851	....	....	....
Quincy	1,895	1,831	1,632	591	616	815	396	349	269
Hannibal	1,909	1,925	1,586	686	760	549	322	237	260
Louisiana	1,195	1,459	1,856	628	705	545	114	110	120

* Ferry-boat, 845 times. † Built in 1880. ‡ Partial record.

CUSTOMS REVENUE AND TONNAGE FOR YEAR ENDING DECEMBER 31, 1881.

That portion of the Mississippi River between Saint Paul and the mouth of the Illinois River lies partly in the customs district of Minnesota and partly in the district of New Orleans. Surveyors of customs are located at Burlington and Dubuque, Iowa; Galena, Ill.; Saint Paul, Minn.; and La Crosse, Wis.

In the following statement is given the total exhibit of the port of Saint Louis, where the greater part of the Upper Mississippi boats are registered, and which includes many of the Lower Mississippi, Missouri, and Illinois river boats:

Port.	Collections.	Enrolled tonnage.	Vessels.
Saint Louis	$1,382,673 32	180,577	310
Burlington	2,014 03	3,963	85
Dubuque	649 62	4,191	26
La Crosse	(*)	6,458	45
Galena	5,412 84	2,179	23
Saint Paul	58,793 43	3,633	....

* Receipts included in those of Galena.

INTERNAL REVENUE.

There are ten internal-revenue districts bordering on the Mississippi River betwe Saint Paul and the mouth of the Illinois River.

Each of these districts is composed of a large number of counties, the greater porti of which do not touch the river, but the bulk of the revenue to the government com from the sections bordering on the river and tributary to its navigation and co merce. I give below a table showing the designation of the districts touching on th river between the points above named, the residence of the collector, and the amou of collections for year ending December 31, 1881:

District.	Residence of collector.	Amount collected for the year ending December 31, 1881.
First Minnesota	Albert Lea	$114,7
Second Minnesota	Saint Paul	328,141
Second Wisconsin	Madison	181,18
Sixth Wisconsin	Sparta	158,25
Second Iowa	Davenport	279,45
Third Iowa	Dubuque	309,07
Fourth Iowa	Burlington	178,74
Third Illinois	Sterling	603,45
Fourth Illinois	Quincy	1,208,11
Fourth Missouri	Mexico	433,8
Aggregate		3,795,025

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

U 2.

IMPROVEMENT OF THE MISSISSIPPI RIVER FROM SAINT PAUL TO DE MOINES RAPIDS.

Under this appropriation are carried on works for the improveme of the through navigation of the river. The constructions consist brush and stone dams and shore protections, and their objects are close secondary channels and reduce the river to a width proportiona to the amount of water discharged, thus securing a sufficiently deep an uniform channel, and to protect the heads of islands and other cavin banks so as to prevent further additions to the bars of the river. Du ing the past season work was carried on by contract at Wabasha, W nona, and Coon Slough, and by day's labor between Saint Paul an Hastings, at Rush Chute and Shokokon Slough. For the details of th work I would refer to the appended reports of Mr. M. Meigs, Unit States civil engineer, and of Messrs. E. F. Hoffman and J. L. Gillesp assistant engineers.

During a large portion of the year the Upper Mississippi River wa at a flood stage, which greatly interfered with procuring material an carrying on work.

During the brief moderate stage of June, 1881, the beneficial resul of the work done were very evident, but during the past year there has not been a sufficiently continuous low stage to permit of any satisfactory examinations which would give a correct idea of the condition of the low water channel. It is hoped that this work may be done during the coming fall.

The moderate appropriations heretofore made for works on the river between Saint Paul and Des Moines Rapids, and the necessity of assisting present navigation as well as the future, render it necessary to select each year points for improvement which may be for the time being the most serious obstructions. The channel of the river changes materially during high stages, and the troublesome points cannot be predicted until the river falls sufficiently to develop them. It is therefore impossible, as a rule, to lay out work long in advance, or to prepare satisfactory specifications as to locality and nature of work. This makes it necessary to do a large proportion of the work by day's labor and purchase of material in open market. Another difficulty in the way of contract work is, that there are but a very few contractors prepared with a sufficient plant to undertake work connected with river improvement, and very few desire to go to the expense of procuring such a plant with a prospect of but one comparatively small contract. But contracts for work at a few points can be prepared, and as many of such points will be selected for the work of the coming year as circumstances permit. The remainder of the work will be carried on by means of the government plants which have been accumulated during the past two years, and which are available for work on this section of the river. These plants now consist of four tow-boats, three steam-launches, fifty-five stone-barges, and the necessary complement of quarter-boats, pile-drivers, &c. With such funds as may be available during the year ending June 30, 1883, work will be continued between Saint Paul and Hastings, between Read's Landing and Alma, in Coon and Cassville sloughs, in the vicinity of Fort Madison and Burlington, and it is hoped works may be inaugurated near Richmond, Dresbach, Trempealeau, and Montrose, in Crooked Slough, and at such new points of obstruction as the low water season may develop.

The long-continued high stage of the river has caused many changes in the channels, and it is very probable that when the low water season comes much trouble will be experienced for a time at those places which are yet unimproved. It is proposed to furnish aid to navigation at such a time by marking new channels and changes to as great an extent as circumstances will permit.

The necessity for owning and operating a dredge on this section of the river continues. Appropriations heretofore made have not been sufficient to justify diverting a sufficient amount for procuring such an outfit.

Experiments in willow-planting were made last season, and good results were promised, but it is very probable that the long-continued flood-stage has destroyed most of the plants set out. These experiments will be continued, as well as those for holding and building up bars by means of temporary obstructions.

The act of Congress of March 3, 1879, provided that $20,000 might be used for testing the "Adam's flume" under the supervision of the inventor, but nothing has yet been done towards putting the flume to a practical test.

The bars on the river above Alma are being gradually removed, and unless his machinery is soon put in operation no such conditions as are desired by Mr. Adams will remain on the section of river in which h desires to experiment.

The present system of improvement of the Upper Mississippi Riv has now been worked under for four years, and as far as results go th work can no longer be termed experimental. At such points as the li ited appropriations have permitted comparatively complete improv ments to be made, all obstructions to navigation have been done aw with. New obstructions will make their appearance on parts of th river yet unimproved, but these obstructions can be as easily remov as others have been. The principle being well established, by resul already obtained, that the system of improvement now being carried o will give a good and permanent channel from Keokuk to Saint Pa suitable for the largest class of river boats during the entire season navigation, it would seem desirable, in case such improvement is co sidered advisable, that appropriations should be sufficiently large give relief to commerce within a reasonable time. The appropriatio heretofore made, while appearing large in the abstract, are very sma when the length of this section of the river and the number of obstru tions are considered.

To do this work promptly and economically not less than $750,0 should be appropriated for the fiscal year ending June 30, 1884, and th government is now well prepared to carry out work under such an ap propriation. As evidence of the valuable results already accomplishe with comparatively limited means, and for opinions as to what is re quired for the future, I would refer to report of "Mississippi River Com mission," printed as House Ex. Doc. No. 95, Forty-sixth Congress, thir session, and a pamphlet published by the combined lumbering interes of the Mississippi Valley and presented to Congress in 1881, and to th expressed views of all whose interest in the improvement of navigatio have led them to a personal knowledge of the facts.

SUMMARY OF EXPENDITURES FOR FISCAL YEAR ENDING JUNE 30, 1882.

Saint Paul to Hastings	$42,186
Wabasha	28,791
Rollingstone, Betsy Slough, Wild's, and Winona	33,338
Coon Slough, dredging	4,221
Rush Chute	6,499
Shokokon Slough	18,776
Keithsburg	1,135
Purchase of plant, &c	65,781
Purchase of material (on hand)	5,762
Water-gauges	239
Snag-boat General Barnard	606
Total expended	207,340

NOTE.—Of the above amount, the sum of $754.91 was reported as outstanding li bilities in last annual report.

ABSTRACT OF APPROPRIATIONS.

By act approved June 18, 1871	$250,0
By act approved March 3, 1879*	100,0
By act approved June 14, 1880	150,0
By act approved March 3, 1881	200,0
	700,0

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*$20,000 set aside for testing "Adams Flume."

Money statement.

July 1, 1881, amount available		$244,108 68
Received from sale of fuel		72 00
		244,180 68
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$207,340 77	
July 1, 1882, outstanding liabilities	15,500 00	
		222,840 77
July 1, 1882, amount available		21,339 91
Amount appropriated by act passed August 2, 1882		250,000 00
Amount available for fiscal year ending June 30, 1883		271,339 91
Amount that can be profitably expended in fiscal year ending June 30, 1884		750,000 00

REPORT OF MR. J. L. GILLESPIE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Saint Paul, Minn., July 1, 1882.

SIR: I have the honor to submit the following report of operations under my charge during the fiscal year ending June 30, 1881:

I. OPERATIONS IN 1881.

SAINT PAUL TO HASTINGS.

An allotment of $50,000 was made for this section of the river from the appropriation "for improving Mississippi River from Saint Paul to Des Moines Rapids" approved March 3, 1881. The work was done by hired labor, materials being purchased in open market. The prices paid for materials delivered on barges furnished by the United States were as follows: Rock, $2.75 to $3 per cord; brush, $2 per cord; poles, 3 cents each. The towing was done by United States tow-boat No. 1 and steam-launch No. 1, assisted by United States tow-boat No. 2 after October 23. During the early part of the season it was necessary to hire barges, at a total cost of $1,500.

An agreement was made with Robert Wilson, of Prescott, Wis., to build nine barges, to be delivered July 1, but for various reasons the last barge was not finished until October 13. On October 23 five additional barges were received. Work was commenced June 13, and closed, on account of ice, November 17. Up to the 1st of September the weather and stage of water were propitious, but during the early part of that month the river rose rapidly from 5 to 9 feet, a very unusual occurrence at this season, when it is commonly at the lowest stage, and, fed by constant rains, continued at a stage of from 10 to 13 feet to the close of navigation, this being the highest water on record for the months of September, October, and November.

The high water and frequent rains interfered seriously with the work, increasing the cost and preventing the proper leveling and finishing of the dams and shore protections, which must be done the coming season as soon as the water permits. The work accomplished during the season was as follows: Twelve closing-dams (4,155 linear feet), built to a height of 4½ feet above low water of 1864, cutting off nearly all side sloughs and chutes between Saint Paul and Hastings, and thereby confining the river, when below a 4½-foot stage, to a single channel; raised two dams at Island 17, and three near Prescott Island (2,235 linear feet), to a height of 4½ feet above low water. The dams at Island 17 were built in 1874 and 1875, and those at Prescott Island in 1878, to a height of about 1½ feet above low water; shore protections were built at heads of islands 10, 11, 12, and 19 (590 linear feet), besides shore protections at the ends of each dam, which are considered as forming part of the dam.

In addition to the above, 8 stone-barges and one working-barge were built; a small pile-driver was constructed, principally from material on hand and the boiler and engines of the wrecked steam-launch Wasp, and fifty-one snags and thirty trees were removed. The materials and methods of construction were similar to those heretofore used and described in previous reports. The lowlands being flooded, willows could not be procured in sufficient quantity, but the young growth of oak, maple, and cottonwood on the higher ground made equally good facines with but little extra labor. The facines used were 12 feet in length.

The work of the past season is preliminary to the prosecution of a general plan of improvement for this section of the river, to be completed hereafter by contracting the width of the stream where obstructions exist, by means of spur-dams, and protecting the heads of islands and cutting banks to prevent further abrasion. The unusual continuance of high water has doubtless caused many changes in the channel, rendering it impossible to predict at what points improvements will be most needed the coming season, but it is probable that Frenchman's, Lower Red Rock, Robinson's, and Nininger bars will be among the first to require attention.

BETWEEN REED'S LANDING AND WABASHA.

This work was done under contract with Mr. S. J. Truax, of Hastings, Minn., dated May 27, 1882, Assistant Engineer G A. Marr in local charge. The prices paid for materials in place were, rock, $1.59 per cubic yard; brush, $1.10. Work was commenced early in July, and completed November 20.

A closing-dam (No. 3, sheet 13) was built from the right bank to Drury's Island (No. 29), and continued across the island to its east bank; thence a spur-dam (No. 2, sheet 13) was constructed extending out into the main stream 1,210 feet, and contracting the channel to a width of about 900 feet. A second spur-dam (No. 1, sheet 13) was built, commencing on the right bank about 1,800 feet below Drury's Island, 1,600 feet in length.

All of the above dams were constructed of brush and stone in the usual manner, and raised 4 feet above low water. The last-named dam was finished during high water, and Mr. Marr estimates that about 500 cubic yards additional stone will be required to level it up to grade. On the left bank 730 linear feet of shore protection were constructed opposite and below the spur-dam from Drury's Island, and 1,725 feet opposite the lower spur-dam. This work was done during high water, and will require leveling and finishing at a lower stage.

The average width of the shore protection is about 25 feet, costing $2.90 per linear foot.

During July and August the weather and stage of water were favorable, but during the latter part of the season frequent rains and high water interfered seriously with the work. Mr. Marr reports seventeen rainy days in September, and fifteen in October. The high water prevented any examination to determine the effects of the works. The proposed spur-dam from the left bank opposite Wabasha and additional shore protection should be built the coming season, and the work of last year leveled.

Summary.

Location.	Length.	Rock, at $1.59 per cubic yard.	Brush, at $1.10 per cubic yard.	Amount.
	Lin. feet.	*Cub. yds.*	*Cub. yds.*	
Right bank, to Drury's Island (dam 3, sheet 13*)	1,000	1,989.00	1,229.10	$4,514 52
Spur from Drury's Island (dam 2, sheet 13)	1,210	2,314.49	2,065.65	5,952 25
Spur below Drury's Island (dam 1, sheet 13)	1,600	3,734.25	2,688.20	8,894 44
Wisconsin shore protection	2,455	2,839.72	2,366.40	7,118 19
		10,877.44	8,349.35	26,479 40 2,312 56
				28,791 96

* The sheets referred to are the general maps of survey, Saint Paul, Minn., to Grafton, Ill.

II. OPERATIONS IN 1882, TO JULY 1.

SAINT PAUL TO HASTINGS.

Work was begun June 10 with United States towboat No. 1 and plant, and continued to the end of the year, and on July 1, 1882, the following work had been accomplished: Shore protections at heads of Islands 2, 3, 5, and 6 completed; shore protectio at head of tow-head above No. 3 begun; dam No. 2 (sheet 3), closing Newport Chute begun in 1878, was raised to a height 4½ feet above low-water; dam No. 3 (sheet 3) closing dam from Island 6, completed; dam No. 6 (sheet 3), closing dam from Island 3 completed; dam No. 5 (sheet 3), closing dam from Island 4, begun; also considerable work on dam 11 (sheet 2), closing dam from tow-head above Island 3, and on dam

12 (sheet 2), closing the chute of Island 2. During the fiscal year 17,160 cubic yards of rock and 17,120 cubic yards of brush were put in the works. About 3,750 yards of rock got out during the winter are still on hand.

Very respectfully, your obedient servant,

J. L. GILLESPIE,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, May 12, 1882.

MAJOR: I have the honor to submit the following report of operations in my charge during the working season, 1881:

Between Chimney Rock and Winona, operations were carried on at several points as mentioned below. The entire work in this section was done under contract with Mr. Jacob Richtman, of Fountain City Wis., between June 27 and November 3, 1881.

AT ROLLINGSTONE BAR.

It was found that dams 6 and 7 were too low to be of much effect, and both were raised to a height of 6 feet above low water. Dam 6 was prolonged 100 feet in a line parallel with the current, making a long T-head. Dam 1 was raised somewhat, and was extended out 900 feet. The gaps 200 feet wide in this and the closing-dam at Island 57, left open for the passage of rafts, continue to allow the escape of a considerable amount of water which should be forced out into the main channel. I think that in due course of time the two dams will effect a shoaling of the upper end of the Rollingstone Slough near Island 56. This will dispose of the problem, and there is no doubt but that the dams have been of great benefit to the channel already. I am told that the water shows a tendency to come in below dam 1 around its end, and I think it would be well to give this dam a long T-head or slant downstream to carry the head of water considerably below the point of the dam. It is very essential that at the first favorable opportunity of low water a survey should be made of this locality, as well as of that from the head of Betsy Slough to Winona.

There are several places that will need shore protection. I would call especial attention to that on the main shore below dam 9.

AT BETSY SLOUGH AND WILD'S.

It was found necessary to extend the riprap shore protection above the foot of Betsy Slough. which was originally built in 1879; 1,100 feet were put in, although the high water made it difficult to work. The bank had been cutting very rapidly, owing apparently to a change in the direction of the current since the first riprap was built at the then point of attack. Island 63 should be also riprapped near the head in Betsy Slough. Below Betsy Slough the bar on the left shore seemed to be moving down so as to threaten the channel to the left of Island 65, and a very apparent shoaling had taken place, with a deepening of Blackbird Slough. It was decided to stop this escape of water by dams from Island 66 to 65, and from Island 66 to the Minnesota shore These were built 5 feet above low water, and the head of Islands 66 and 65 were riprapped.

ABOVE WINONA.

A change in the channel above and at Argo Island made necessary the construction of additional works.

The channel threatened to pass to the left of Argo Island, and the old channel became a mere pool with very little water. Dam 15 was thrown out from the Wisconsin shore, and Argo Island, already disappearing rapidly under the influence of the strong current, was dug down level with the water and trenched from end to end, all stumps and roots being grubbed up

Four hundred and fifty feet of riprap was found necessary on the point opposite Argo Island, and repairs were made on dams 16 and 20. Dam 18, unfinished at close of navigation in 1880, was completed with rock and a strong T-head built.

Summary of work at Rollingstone, Betsy Slough, Wild's, and Winona.

Locality.	Description.	Quantity.	Brush, at 90 cents per cubic yard.	Rock, at $1.40 per cubic yard.	Amount.
		Lin. feet.	*Cu. yds*	*Cu. yds.*	
Rollingstone	Dam 1 (sheet 17)	900	2,144	1,996	$4,723 53
	Dam 6 (sheet 17)	Repairs and extension 100feet.	1,007	1,041	2,363 46
	Dam 7 (sheet 17)	Repairs.	417	335	843 65
Betsy Slough	Riprap (sheet 17)	1,100	1,292	1,067	2,656 95
Wild's	Dam 3 (sheet 17)	470	960	1,390	2,809 74
	Dam 4 (sheet 17)	590	2,022	2,172	4,860 69
	Riprap Island 66 (sheet 17)	500	446	628	1,280 44
	Riprap Island 65 (sheet 17)	500	1,277	1,471	3,209 17
Winona	Dam 18 (sheet 18)	Repairs.	142	407	697 73
	Dam 15 (sheet 18)	960	1,069	1,543	3,122 23
	Shore protection opposite Argo Island (sheet 18).	450	779	591	1,527 60
	Riprap Island 71 (sheet 18)	800	842	785	1,857 67
	Dam 20 (sheet 18)	Repairs.	94	107	234 36
	Dam 16	do	15	149	222 77
			12,506	13,682	30,409 69
Argo Island, labor					151 96
Superintendence and office expenses.					2,777 20
Total					33,338 85

Average cost per yard, including contingencies, $1.23½.

COON SLOUGH BENDS.

About 15 miles below La Crosse, Wis., the low water channel is through a narrow but very deep arm of the Mississippi called Coon Slough. The general depth of the water is excellent, but navigation, especially by rafts and steamers with a tow, is very difficult, owing to the sharp bends. At one point in the slough it is further complicated by violent currents, and also a small tow-head just below the first bend, and which has been the occasion of disaster to many rafts. The narrowness and crookedness of this place is such that only half a raft can be taken through at ordinary stages of water, and then with difficulty, necessitating a double trip with each raft of from 5 to to 10 miles. It was decided to remove the tow-head by dredging and to make a cut-off across the peninsula at the upper bend. Only a narrow cut was made, as it is expected the current above will, in the course of a short time, widen the new channel sufficiently for the passage of boats and rafts.

Authority for the work was obtained October 1, 1881, and an informal contract made with Whitney & Son to do the work by the hour, at $11 per hour. October 13, work began and was prosecuted to the close of navigation. The results are as follows: First. Two cuts across the peninsula, making a channel 40 feet wide and 8 feet below the top of the banks, say a depth of 2 feet above low water for the bottom of the channel. The excavation was carried down to a stratum of sand. Second. The removal of the tow-head to a depth of about 3 feet above low water. It was not considered necessary to carry this any deeper, as there was a strong current of water over the spot. The high stage of water prevailing during October was very favorable for the work, the dredge being able to float over the submerged bank of the slough.

SUMMARY OF WORK.

369 hours and 50 minutes' use of dredge, at $11 per hour	$4,068 17
Superintendence and office expenses	153 63
Total	4,221 80

Fifteen thousand cubic yards of material were taken out, at a cost of 28¼ cents per yard.

MATERIAL.

An agreement was made with Mr. Otis Warner, of Warner's Landing, in Coon Slough, to furnish 4,000 cubic yards of rock on the bank at that point at a cost of 50 cents per yard, in anticipation of work near La Crosse, Wis. The extreme high water made operations in that locality inexpedient, and the rock still remains for future use. About 80 per cent. of it has been paid for. An agreement was also made with Mr. Nils Peterson to get out and pile on the bank at Glen Haven, Wis., 5,000 cubic yards of rock at 60 cents per yard, with the intention of using it last season in the improvement of Cassville Slough. High water prevented our intentions from being carried out, and the rock is on hand for future use. Estimates to the amount of about 75 per cent. have been paid.

In August, 1881, a brush gang was put at work on the island below Buena Vista. They were forced on September 5 to stop work on account of high water. There were 2,295 yards of brush cut and made into fascines at a cost of $1,093.50.

CONSTRUCTION OF STEAMERS AND BARGES AT DUBUQUE, IOWA.

An agreement was made with Mr. Joseph Reynolds in April, 1881, for the construction of two stern-wheel tow-boats of the following dimensions: Length, 100 feet; beam, 20 feet; hold, 4 feet; diameter of wheel, 13 feet; engines 10¼ inches diameter, 4 feet stroke; boiler, 22 feet long, 42 inch shell, with ten 6-inch flues. The whole to be of best material and workmanship.

The first of these boats, the Fury (No. 2), came out October 3, 1881, and the second, the Vixen (No. 3), November 10. The cost of these boats with outfit, &c., complete was $23,842.96, or $11,921.48 each.

Four barges, 80 feet by 16 feet by 4 feet 6 inches, were contracted for with Mr. Reynolds, April 26, 1881, at a price of $600 each, and were completed October 1, 1881.

CONSTRUCTION OF BARGES AT CLINTON, IOWA.

The pressure of work in all the boat-yards along the river made it impossible to get favorable bids for all of the eleven barges required, and the desire to have a plant ready for use as soon as the favorable stage of water occurred made it necessary to build seven barges by day's labor. Clinton was selected as the best place for the purpose on account of the facilities for procuring lumber.. Work was begun early in June, and two barges were finished during the month, and on the 30th of August the last of the seven barges was put in the water. The barges are:

One, 100 feet by 20 feet by 4 feet 6 inches.
Three, 80 feet by 16 feet by 4 feet 6 inches.
Three, 80 feet by 16 feet by 4 feet.

The cost of the seven barges was $5,884.68.

I am under obligations to Mr. A. J. Stibolt and Mr. J. E. Blakemore, inspectors, for zealous and able supervision of work intrusted to them.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. E. F. HOFFMANN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1882.

MAJOR: I have the honor to present my annual report of operations on works in my charge for the fiscal year ending June 30, 1882.

AT KEITHSBURG BAR.

During the fall of 1880 a cut of 80 feet wide was dredged through the gravel and bowlder bar near Keithsburg.

In August, 1881, a survey of the locality was made to determine the effect of the extreme high water on the cut. There were taken and plotted 12,500 soundings, which showed that while little filling had taken place, there still remained about 5,800 cubic yards of sand, clay, gravel, and bowlders to be removed to complete the cut. Authority to expend $5,000 on this work from appropriation of March 3, 1881, for improving Mississippi River from Saint Paul to Des Moines Rapids was granted, and an agreement was entered into with Whitney & Son to remove the material by dredge at 66 cents per cubic yard. Extreme high water which followed the examination prevented any work being done.

RUSH CHUTE AND HARBOR OF BURLINGTON, IOWA.

The project for improving the river in this vicinity is given in your last annual report under head of "Improvement of Rush Chute and Harbor at Burlington, Iowa." The work at that time was carried on under a special appropriation, which was exhausted June 30, 1881. Since that date work under the project has been carried on under an allotment from the general appropriation, Mississippi River, Saint Paul to Des Moines Rapids. During the early part of the year the extreme high water prevented the delivery of rock, and work was much delayed. From July 25 until August 22 the work accomplished was the storing of 850 cubic yards of rock on Rush Island, the collection of a quantity of brush, and making same into fascines, and building and fitting up mattress and quarter boats.

Dam No. 2 (sheet 58) was commenced August 22 and completed September 3. This closing dam connects Rush Island (379) with a small island in the chute, and is intended for the improvement of a shallow crossing opposite the latter island. The results were most satisfactory. This dam is 196 feet long, has a base of 35 feet, and an average height of 10 feet, being brought to a grade of 4 feet above low water of 1864. There were used in this dam and its shore protections 1,013 cubic yards brush, and 1,198 cubic yards rock.

Dam No. 3 (sheet 58) was commenced September 6 and completed September 17. This closing dam connects Islands 374 and 376. It is 460 feet long, with a base of 32 feet, and an average height of 4½ feet above low water of 1864. The object of this dam was to improve the channel at the foot of Rush Chute. No opportunity has yet been offered to determine its effect. The dam contains 960 cubic yards of brush, and 1,225 cubic yards of rock.

The stone used for dams 2 and 3 was obtained by public notice and sealed proposals. The rock was loaded on barges belonging to the United States at the quarries below Burlington, for 95 cents and $1.08. Brush was obtained by day's labor. Towing was done by United States tow-boat No. 4, and material was put in by day's labor.

SHOKOKON SLOUGH.

In October, 1880, authority was granted for closing Shokokon Slough for the improvement of the very bad bar known as Burlington Crossing. The entrance to the slough being shallow and rocky, it was feared trouble might be experienced in low-water, and advantage was taken of the high water in early part of 1881 to deliver a quantity of rock at the site of the dam.

Work on the construction of dam No. 1 (sheet 59), which extends from Illinois shore to Sauerwein's Island and closes the east branch of the slough, was commenced September 19, 1881. After laying one continuous mat across the chute and 300 feet of a second course, work was suspended on account of the impossibility of obtaining brush, which was covered with flood water. This dam is about 1,000 feet long, and contains in its present condition 1,340 cubic yards of brush and 1,055 cubic yards of rock.

Dam No. 2 (sheet 59), which extends from Sauerwein's Island to Burlington Island (377), closes the west branch of Shokokon Slough. Owing to high water, which prevented obtaining brush, it was determined to construct this dam of rock alone if a proper foundation could be found. Borings commenced October 7, and taken from 40 to 80 feet apart on proposed line showed a hard bottom, and on October 9 the construction of the dam was commenced, and continued to November 24, when running ice put a stop to operations.

This dam was brought to an approximate height of 6½ feet above low water of 1864, and contains 5,120.21 cubic yards of rock. As the dam was built at a very high stage of water its top could not be properly leveled, and a little more work will be required. The present condition of this dam cannot be stated, as it has been completely submerged since its construction and no satisfactory examination could be made. The completion of these dams 1 and 2, which will effectually close Shokokon Slough, must have a most beneficial effect on the main river, as the slough formerly carried one-third of the discharge of the river at this point. The completion of the work is of great importance, and should be carried out as soon as funds are available and the stage of water permits work to be resumed.

COST OF WORK AT RUSH CHUTE AND SHOKOKON SLOUGH.

There has been expended on these works during the past year, including office expenses and contingencies, $25,276.49, to which must be added $3,999.65 expended for storing material, &c., during the previous year, making a total expenditure of $29,276.14. Deducting from this the cost price of rock now on hand and not yet used, $7,211.07, we have for cost of material in place $22,065.07.

There were 11,911.21 cubic yards of material put in the dams, which gives a cost per yard of $1.85. Nearly all the work done in the vicinity of Burlington was carried on at a very high stage of water and in a correspondingly swift current.

All the rock for the Rush Chute dams was towed upstream 8 miles through the Burlington bridge.

At the beginning of the year tow-boat No. 4 (Hiram Price), purchased in June, 1881, four barges, and one quarter-boat were available for work in the vicinity of Burlington. This plant was increased during the season by the addition of seven stone barges and one mattress boat.

Steam launch No. 3 (Lucia) and the drill-boat belonging to Rock Island Rapids improvement were also made use of.

BUILDING BARGES AT DAVENPORT, IOWA.

There were built during the year by Eckhardt & Son the following barges, &c.: Fourteen decked flats, 68 feet by 16 feet by 4 feet, at a cost of $548, for use as stone-boats; one flat, 100 feet by 20 feet by 4½ feet, at $925, for use as a mattress-boat; eight flats, 80 feet by 16 feet by 4 feet, at $685, for stone-boats; two flats, 100 feet by 20 feet by 4½ feet, at $950, for mattress-boats; two 52 feet by 18 feet by 3 feet, at $500, for pile-drivers; one 70 feet by 20 feet by 3 feet, at $700. This latter carries a two-story house on it, and is to be used as a quarter-boat, and will comfortably accommodate fifty men.

BUILDING BARGES AT DUBUQUE, IOWA.

Arrangements were made with Mr. Joseph Reynolds for building ten barges 80 feet by 16 feet by 4 feet at a cost of $660 each. These barges are nearly completed.

Very respectfully, your obedient servant,

E. F. HOFFMANN,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

U 3.

IMPROVEMENT OF THE MISSISSIPPI RIVER FROM DES MOINES RAPIDS TO MOUTH OF THE ILLINOIS RIVER.

With this appropriation works for the benefit of through navigation are carried on at points selected each year in accordance with the needs of navigators.

At the beginning of the year our projects included the continuance of operations in the vicinity of Gilbert's and Denmark islands and the raising and strengthening of Canton and Smoot's Chute dams.

Work at these points was carried on by hired labor and purchase of material in open market, the United States tow-boat No. 5 and plant being used for handling the rock and putting the same in place.

In April, 1881, the river began rising and maintained throughout the greater part of the season a flood stage, the only interval of moderate water favorable to our work occurring in latter part of July and early part of August, when the weather was too hot to permit of active operations.

The late opening of navigation, running ice, protracted high water, excessively hot weather in midsummer, together with bad roads to quarries, owing to high water, and consequent slow and uncertain delivery of rock, the scarcity and high price of fuel, &c., formed a combination of circumstances unfavorable to economy in work, and the cost was much greater than was hoped and expected.

Work has not been resumed in 1882 on account of high water.

To Mr. O. N. Chaffee, assistant engineer in charge of operations in this section of river, much credit is due for zealous and effective work.

VICINITY OF GILBERT'S AND DENMARK ISLANDS.

In the spring of 1881 the river at above localities not showing the improvement desired it was determined to raise and strengthen several of the dams which had been built in previous years, and also to continue work upon the Denmark Island Dam. Work was begun early in the season and continued until July 15, resumed August 16, and continued from that time until December 10, when operations were interrupted by cold weather and the fleet was sent into winter quarters at Quincy.

The dam across Gilbert's Chute was raised to about an average elevation of 7½ feet above low water, and Dam No. 4 from Illinois shore and the wing-dam from foot of Gilbert's Island to about 6 feet. The Gilbert's Chute Dam was somewhat damaged by ice in winter of 1881–'82.

Much work was done on the Denmark Island Dam during the season, but cold weather caused a suspension of operations before it was completed. Some 8,800 yards of rock were used in this part of the work. The total amount of material put in during the year in vicinity of Gilbert's and Denmark islands was 12,376.20 cubic yards.

A survey of the river from Cincinnati Landing to Mundy's Landing, made late in 1881 by Inspector W. A. Thompson, shows great improvement in several of the formerly bad crossings, but demonstrates the necessity of completing the Denmark Island Dam for the betterment of the crossing at Mundy's Landing.

CANTON AND SMOOT'S CHUTE DAMS.

On September 19, 1881, the work of raising and strengthening the two dams above mentioned was begun and carried on until October 31, when extreme high water caused discontinuance of operations.

The dams were carried up to an elevation of 7½ feet above low water. It was intended to build them higher, but the unusual high water so increased the expense that the work was abandoned until another season. These dams are reported to have been injured in winter of 1881–'82 by the ice, which went out at a much higher stage than usual.

There were put in this work 5,882 cubic yards of rock, at a cost, including superintendence, office expenses, &c., of $10,066.16.

GREGORY'S LANDING.

The project for this work includes the construction of a dam from Hackley's Island to the tow-head, and the protection of a long piece of bank above Fox River.

The contract was awarded to Whitney & Son in August, 1880, but the work has been so much interfered with by high water that their contract has been extended to December 31, 1882, and some additional quantities of material have been added to the estimates, to be put in the work at the original contract price.

Work on dam was resumed September 10, 1881, and continued to October 15, and then stopped on account of a flood in the river.

In 1882, operations were carried on from April 15 to 22, when the river rising and covering the banks compelled a discontinuance.

SUMMARY OF WORK.

1,951.53 cubic yards brush, at 90 cents	$1,756 38
2,535.16 cubic yards rock, at $1.55	3,929 50
	5,685 88
Less ten per cent. retained	568 59
Amount paid contractors	5,117 29
Superintendence and office expenses	1,701 48
Total paid during year	6,818 77

PURCHASE OF AND REPAIRS TO PLANT.

Considerable additions were made to the plant belonging to this appropriation during the past year, partly by purchase and partly by building at Quincy, Ill. Six model barges have been contracted for on the Ohio River, three at Metropolis, Ill., and three at Jeffersonville, Ind. These barges are now nearly ready for delivery. A dredge and six dump-boats are also in process of construction. The machinery for dredge is being built by Osgood & McNaughton, of Troy, N. Y., and the hull for same and six dump-boats by Jacob Eckhardt & Son, of Davenport, Iowa. Considerable repairs were made to tow-boat No. 5 and plant during the past winter and spring.

QUARRY AT DIXON'S LANDING.

On account of the difficulty of obtaining sufficient quantities of stone as needed and the high price at which it is held by private parties, it was deemed advisable for the government to open several quarries at different points, and, working them by day's labor, obtain a supply of rock in advance, and at the same time determine experimentally the actual cost of procuring and loading rock on barges under varied conditions.

An excellent site for a quarry was found between Dixon's and Brock's landings, about 10 miles above the mouth of the Illinois River. The rock crops out along the shore in such a manner that but little stripping is needed, and where boats and barges can readily gain access. The right to quarry privileges on some 800 feet of the shore was obtained, and a force of men set at work on May 24, 1882.

Work has been continued to the present time with from twenty-five to forty-five men, and some 9,600 yards of rock have been taken out, broken up, and piled on the bank, at a total cost of $4,056.02.

QUARRIES IN KEOKUK CANAL.

For reasons mentioned above a quarry was opened at Ballinger's, in the Des Moines Rapids Canal, on April 10, 1882, with a force of twenty men. The stripping at this point being found too heavy, the quarry was abandoned on May 9, and a new quarry opened at Rickey's Point on the same day.

About 2,000 yards of rock have been taken out at both of these places, but neither proved advantageous in an economical point of view.

SNAG-BOAT GENERAL BARNARD.

The appropriation for operating the snag-boat being insufficient, an allotment was made from this appropriation.

CURRENT METER OBSERVATIONS.

Assistant G. A. Marr was employed during a part of the year in the reduction of current meter observations made under direction of Maj. F. U. Farquhar in 1878 and 1879. A progress report on this subject was made in June, 1881, and is contained in my last annual report. There still remains a part of the field work of two days to be reduced and compiled, which being completed, a final report will be rendered with the full tables and plates necessary to make it intelligible.

SUMMARY OF EXPENDITURES FOR FISCAL YEAR ENDING JUNE 30, 1882.

Gilbert's and Denmark Islands	$28, 490 30
Canton and Smoot's Chute dams	10, 066 16
Gregory's Landing	6, 818 77
Purchase and repairs of plant	30, 682 32
Quarry at Dixon's Landing	4, 056 02
Quarries in canal	1, 640 65
Snag-boat	5, 067 38
Meter observations, surveys, and gauge-readers	1, 166 70
	87, 968 30

GENERAL REMARKS.

The general system of improvement followed on this section of river has been fully given in former reports, and will not be here repeated.

The work of the past year has not been pressed, as the exceedingly high stage of water rendered it very expensive and difficult. The results obtained are, as far as can be ascertained, satisfactory, but as there has been no very low water during the year suitable for careful and accurate examinations, the exact condition of the dams and channels cannot be given. Some of the dams have been injured to a greater or less extent by the running ice, which went out at a much higher stage than usual. This danger can only be provided against by building the dams to an excessive height. To what extent the dams have settled has not been definitely determined, but except in a few cases the settlement is not very great. It is hoped that when circumstances permit, this danger of settlement may be almost entirely done away with by providing a wide and deep foundation of gravel.

It is probable when the stage of water permits work to be resumed, improvements will be made at Hackley's, Canton, and Smoot's Chutes, Marion City, Gilbert Island, Denmark Island, and Louisiana, but such points cannot be given with certainty, for the long-continued high stage of water has undoubtedly caused many changes in the channel, which may develop new and more important obstructions. The comparatively small appropriations under which this work is carried on prevent any general order of improvement and necessitate each year the selection of a few of the points which for the time being are the most troublesome.

To carry out this method of working, a large plant has been provided and material collected, and at the shortest notice any portion of the river can be attacked.

As the government is now provided with the plant and outfit needed for carrying on extensive work, and as an economical method of working requires liberal appropriations, it is hoped that if the general system of improvement inaugurated is to be continued this section of the river may be granted the sum of $500,000 for the fiscal year ending June 30, 1884.

ABSTRACT OF APPROPRIATIONS.

By act approved June 18, 1878	$100, 000
By act approved March 3, 1879	40, 000
By act approved June 14, 1880	100, 000
By act approved March 3, 1881	175, 000
	415, 000

Money statement.

July 1, 1881, amount available		$184,217 97
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$87,988 30	
July 1, 1882, outstanding liabilities	48,750 00	
		136,738 30
July 1, 1882, amount available		47,479 67
Amount appropriated by act passed August 2, 1882		200,000 00
Amount available for fiscal year ending June 30, 1883		247,479 67
Amount that can be profitably expended in fiscal year ending June 30, 1884		500,000 00

U 4.

COMPLETION OF WORK OF REMOVING SAND-BAR IN MISSISSIPPI RIVER OPPOSITE GUTTENBERG, IOWA.

As described in last year's report, work at this point was begun in November, 1880, under an allotment of $3,000 from appropriation for improving Mississippi River, Saint Paul to Des Moines Rapids, and that amount was expended in partially constructing a dam of brush and stone across Swift Slough.

By act of March 3, 1881, Congress provided $5,000 for completing this and other proposed work.

On April 5, 1882, tow-boat No. 3 (Vixen) and barges resumed work on the dam. This work consisted in completing about 100 feet of apron, and sinking three layers of mats, 370 feet long, across the chute, and one course, 60 feet in length, near center of dam.

The first two courses of mats, and a part of the third course, are 20 feet wide, the remainder being 12 to 14 feet wide. The portion of apron put in was of 20-foot brush, and the entire apron was made 12 feet wide. The crest of the dam was brought to an approximate grade of 6 feet above low water, the top course being thoroughly covered with a layer of rock 3 to 4 feet in thickness.

AMOUNT OF MATERIAL PUT IN.

	Cubic yards.
Brush	647.00
Rock	1,914.60
Total	2,561.60

On April 18, on completion of dam, the fleet returned to Dubuque, Iowa, and was laid up.

There remains available for shore protection on head of island, &c., the sum of ———, which will be expended during present season.

As present plans do not contemplate any further work in this channel, no additional appropriation is asked for.

ABSTRACT OF APPROPRIATIONS.

By allotment of act approved June 14, 1880	$3,000
By act approved March 3, 1881	5,000
	8,000

Money statement.

July 1, 1881, amount available	$5,0
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	2,47
July 1, 1882, amount available	2,52

U 5.

REMOVAL OF BAR IN THE MISSISSIPPI RIVER OPPOSITE DUBUQ IOWA.

Surveys of the Dubuque Bars were made in August, 1881, and t maps indicated a slight shoaling outside of the area dredged over former years, and it also seemed probable that a radical change in th bed of the river between the levee and the bridge was taking place.

But as there was no complaint in regard to the main bar at Dubuq and as the ferry-boat, owing to the formation of a very shoal bar at E Dubuque, was unable to land there, it was thought best to perform som dredging at the latter point. Authority for the expenditure of $2,0 having been granted, an agreement was made with Whitney & Son f dredging at 25 cents per cubic yard.

Work was begun September 12 and carried on until the 22d, whe on account of high water, operations ceased.

During this time 3,570 cubic yards of material were removed.

The balance now available will probably be sufficient to carry on suc work in connection with the removal of the Dubuque bars as may b necessary during the fiscal year ending June 30, 1884, and therefor nothing is asked for under this appropriation.

ABSTRACT OF APPROPRIATIONS.

By act approved August 14, 1876	15,
By act approved June 18, 1878	10,
By act approved March 3, 1879	4,
By act approved June 14, 1880	7,
By act approved March 3, 1881	5,
	41,

There passed Dubuque Bridge during season of 1881, 4,710 stea boats, 653 barges, and 1,380 rafts.

COMMERCIAL STATISTICS OF THE CITY OF DUBUQUE FOR 1881.

Receipts by river:		
Logs and lumber	feet	81,000,
Oats	pounds	19,969,
Wheat	do	770,
Butter	do	90,
Lead	do	1,700,
Salt and cement	barrels	1,500,
Coal	pounds	27,512,
Passengers		13,

The total shipments, including grain and merchandise of all kinds, amounted about 90,000,000 pounds.

Money statement.

July 1, 1881, amount available	$11,977
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	1,222
July 1, 1882, amount available	10,755
Amount (estimated) required for completion of existing project	9,770

ESTABLISHMENT OF AN ICE HARBOR AT DUBUQUE, IOWA.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., December 31, 1880.

GENERAL: In accordance with directions contained in your indorsement of December 24, 1880, on a letter dated December 21, 1880, from the Hon. Thomas Updegraff to the honorable Secretary of War, referring to the establishment of an ice harbor at Dubuque, Iowa, I have the honor to make the following report, with two sketches attached.

There is no doubt that a good ice harbor is needed in this section of the Upper Mississippi River. Indeed, there are but three points between Saint Paul and Saint Louis, some 700 miles of river, where a boat can be sheltered for the winter and have facilities such as Dubuque offers. The three places are Quincy, where the government has already opened an excellent harbor; Keokuk, where the canal affords a few deep holes of limited area in which a boat can lie during the winter; and La Crosse, where the mouth of Black River furnishes a safe refuge.

It is true there are a few bays and sheltered places under islands and points scattered along the Mississippi where boats can be laid up in comparative safety, but these are generally remote from any town or house, and are at best precarious. Having so few harbors, the most of the steamers are hauled out every winter either on private ways, kept up at considerable expense, or at the several ship-yards along the river, which, however, can accommodate only a portion of the boats. This manner of laying a boat up for the winter entails a heavy annual tax on the owners, the cost of hauling out a steamer varying from $100 to $500, according to the tonnage, besides the calking which is necessary before the boats can be launched again on the opening of navigation. There are from twenty to thirty steamers on this section of the river which would find a convenient ice harbor at Dubuque, besides a great number of barges, wood boats, &c., representing a large amount of property.

The essentials of a good ice harbor for the Upper Mississippi may be summarized as follows:

1st. Absolute safety. This means a bay where there is still-water and freedom from running ice at all stages of the river; also a sufficient depth to float crafts of all sizes, whether loaded or light, that may want a refuge.

2d. Accessibility, or, in other words, nearness to the main channel of the river, with a good chance to get into the harbor even after the ice had begun running.

3d. Convenience to ship-yards, machine-shops, and all the other facilities of a large town.

In the first respect, the harbor proposed at Dubuque leaves nothing to be desired. Third-street embankment, the top of which is 20 feet above low-water mark, forms the upper side of the harbor, and is never overflowed by the river except at extreme high-water, say once in ten years. This extreme high-water never occurs when there is ice in the river, and we may conclude therefore that the harbor below it will be perfectly safe.

In the second respect the harbor has advantages also. There has been a good channel dredged up to its mouth, and the sand-bar marked A in the drawings forms a lee under which boats can take refuge when the ice is running until a passage can be cut for them into the harbor itself.

In the third respect, Dubuque offers as good facilities as any city above Saint Louis for repairing steam and other crafts.

There are large machine and boiler shops, a great lumber market, and a ship-yard, where skilled shipwrights can be secured, making the laying up of a boat at Dubuque particularly desirable.

Waple's Cut, where it is proposed to dredge out a basin, has been for years used by the different Upper Mississippi steamboat lines for a winter harbor, as well as by a great number of other parties owning barges and boats in the wood trade. Of late years, however, it has been gradually filling up by the deposit from the sewers (shown on the maps), by the muddy water coming from the Third-street opening during high stages of water, and by the breaking up and washing off of lumber rafts towed in by hand. Only a small portion of the area included in the map (No. 2) has at present as much as 2 feet at low-water, and boats are consequently liable to become frozen to the mud bottom and sunk when the water rises.

Some arrangement should be made, if the government undertakes to excavate a harbor, by which it can control the movements of craft using it, and prevent the casting of ashes and cinders into the dredged basin, the washing off of rafts, and the deposit of foul matter from the above-mentioned sewers. The depth required is at least six feet at low-water. This leaves a margin for gradual filling, and also for the contingency of the water falling below standard low-water, as sometimes occurs during ice-gorges.

The area required for the boats plying on the Upper Mississippi River ranges from 6,000 to 20,000 square feet each; for barges, 1,000 to 5,000 square feet. The total area within the contour of 3.2 feet above low-water which it is proposed to utilize for a harbor by dredging is 502,500 square feet. This would give room for twenty of the larger steamers and fifty barges, which is ample for present requirements. This area can be readily extended at any time, either by excavating over the whole surface included between Third-street embankment and First street, or by cutting a passage through Third street and making another basin above it. The following table gives the area and the approximate amount of dredging required to give 6 feet at low-water between the lines marked *o o*, *n n*, and *m m*, on sheet No. 2:

Table of areas and approximate amounts of dredging required for an ice harbor at Dubuque, Iowa.

Description.	Area.	Excavation
	Square feet.	*Square yards*
Line *o o* to *n n*	125, 000	35,7
Line *n n* to *m m*	225, 000	55,9
Line *m m* to river	152, 000	42,7
	502, 000	134,4

The embankment on First street should be riprapped, after the dredging along its face is completed, for some 1,100 feet. This would require about 3,000 cubic yards of rock.

The small opening marked B in the Third-street embankment should be closed by a sluice-way to prevent the flow of muddy water at high stages, and at low stages to permit of occasional sluicing to prevent the water in the harbor from becoming stagnant. The cost of this sluice-gate is estimated at $700.

There follows an estimate of the cost of the whole work, on the lines above stated, included within the contour of 3.2 feet above low-water, as shown in sheet 2 accompanying.

ESTIMATE FOR ICE HARBOR AT DUBUQUE, IOWA, TO CONTAIN AN AREA OF 502,000 SQUARE FEET.

Dredging 134,452 cubic yards mud, sand, &c., at 25 cents	$33,613
Riprap, about 1,100 feet on First street, 3,000 cubic yards rock, at $1.50	4,500
Sluice-way at Third-street opening	700
Engineering and contingencies	1,187
	40,000

Very respectfully, your obedient servant,

A. MACKENZIE,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

U 6.

IMPROVEMENT OF ROCK ISLAND RAPIDS, MISSISSIPPI RIVER.

The work contemplated at the beginning of the fiscal year was:

1. To make thorough examinations of the cuts through the various chains, and of other localities where obstructions were reported to exist.

2. To dredge out the loose rock at Saint Louis chain, which had been broken up by blasting with dynamite.

3. To establish channel marks and buoys for the aid of navigation.

Surveys were made at Smith's, Saint Louis, and Campbell's chains in September, 1881.

On account of high water further examinations were postponed until December, when a thorough survey of Duck Creek chain was completed.

These surveys developed the existence of considerable loose rock, and projecting points of ledges, which still remain to be removed, and especially at Duck Creek and Campbell's chains.

An agreement was made with Whitney & Son to dredge at Saint Louis chain, and work was carried on at that point from the 5th to the 18th of August, during which time 415 cubic yards of rock were removed, at a cost of $1,292.

With the exception of two points of rock, which are about 1 foot above grade, and which will probably be cut down by the use of a chisel boat, work at this chain is completed.

During August, 1881, the establishment of buoys, which had been necessarily postponed on account of high water, was accomplished. These buoys have proved to be very useful to navigators, but great difficulty is experienced in keeping them in place, they being frequently swept away by rafts and steamboats. High water the present season has thus far prevented the placing of the buoys, but everything is in readiness for so doing when the water subsides sufficiently.

With the balance of appropriation of March 3, 1881, it is proposed to carry out the unaccomplished portion of the work laid out for last year, and in addition, to maintain the buoys on the rapids. It is hoped that steps may soon be taken to inaugurate the work of widening and deepening the present channel. This was fully referred to in my annual report for 1880.

The money now available will complete this work as originally projected, excepting the removal of obstructions at Duck Creek chain, which work was only developed by surveys made since former estima were prepared.

It is probable this work can be accomplished during the present son by adding to funds available a small allotment from appropriat for "improving Mississippi River, Saint Paul to Des Moines Rapids."

To provide for the expense of the maintenance of buoys, and per nent channel marks, and for the continuance of such inspection a superintendence as is required in the interests of present and fut navigation, a small appropriation should be made annually.

For details of the work I would respectfully refer to the accompa ing report of Mr. E. F. Hoffmann, the assistant in charge.

ABSTRACT OF APPROPRIATIONS.

By act approved June 23, 1866	$10
By act approved March 2, 1867	20
By allotment from appropriation of July 25, 1868	15
By allotment from appropriation of April 10, 1869	13
By act approved July 11, 1870	150,
By act approved March 3, 1871	150,
By act approved June 10, 1872	50,
By act approved March 3, 1873	50
By act approved June 23, 1874	50,
By act approved March 3, 1875	5
By act approved August 14, 1876	2
By act approved June 18, 1878	30
By act approved March 3, 1879	6
By act approved June 14, 1880	[illegible]
By act approved March 3, 1881	[illegible]
Total	1,16

Money statement.

July 1, 1881, amount available	$11,21
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	6,21
July 1, 1882, amount available	4,99
Amount that can be profitably expended in fiscal year ending June 30, 1884	5,00

REPORT OF MR. E. F. HOFFMANN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 18

MAJOR: I have the honor to present my annual report on improvement of R Island Rapids, Mississippi River, for the fiscal year ending June 30, 1882.

The water in the river remained at such a high stage during July, 1881, tha proposed establishment of buoys had to be postponed, but during the month the ste launch Lucia towed the steam-drill and other boats up the rapids to upper chain, a field party established bench-marks near the different chains to be used in the p posed surveys.

Preparatory work in reference to dredging at Saint Louis chain was also perform

In August the system of buoys was placed. Twenty-two spar-buoys were used, e 12 feet long, and of 12 and 4 inches diameter at the ends. They were attached by ch to ring-bolts inserted in the rocky bottom by aid of the steam-drill.

Years of experience and experiment have shown the difficulty of holding buoy their places on these rapids, they being sooner or later detached by passing rafts the twenty-two buoys established in 1881 but eleven were found at the close of season of navigation, the remainder having been wrenched away and lost.

An agreement was made with Whitney & Son to remove by dredge a patch of ro at Saint Louis chain, which had been broken by blasting with dynamite in 1879. no exact estimate could be made of the quantity of rock to be removed it was deci to hire the dredge by the hour, and the price agreed upon was $12. On Augus dredging was begun at Saint Louis chain and continued until the 18th. During th

o 415 cubic yards of rock were removed and dumped on the Illinois shore at a cost
$1,292.
Excepting at two points, which were found to be 1 foot above grade, the subaqueous
sting was found well executed. These points will be cut down by chisel-boat, as
rock being already partly shattered would not show good results in blasting.
Considerable of the rock of Saint Louis Chain which had been broken up by blasting,
st have been carried into deep water by ice, as much less was found and removed
the dredge than had been estimated as broken up.
In regard to the relative merits of chisel work and subaqueous blasting, I may say
t for working a comparatively large area of rock to a depth of 1 foot or less in
erage, the chisel is preferable, but for small areas and deeper excavations blasting
ves better results. Both methods are, however, inferior when the area and quantity
excavation are sufficient to justify the construction of a coffer dam.
For the purpose of ascertaining if loose rock had been carried into the various cuts by
gh-water or ice, a survey was ordered, and a party took the field in September, 1881.
In September Upper Chain, Saint Louis Chain, and Campbell's were thoroughly
unded, some eleven thousand soundings being taken.
The surveys were stopped by high water, but resumed in December, when a careful
amination of Duck Creek Chain was made, seven thousand soundings being taken
that point.
These surveys were plotted in winter 1881–'82, and the maps developed consider-
le rock obstruction at Duck Creek and Campbell's chains.
It is proposed to break up the rock thus discovered by means of a chisel boat, and
move the fragments with a dredge. The steam launch Lucia did excellent service
ring the season in placing buoys and towing steam drill into position.
Preparations have been made for placing buoys during present season, but the river
s thus far remained so high as to prevent the proper execution of the work.

Very respectfully, your obedient servant,

E. F. Hoffmann,
Assistant Engineer.

Maj. A. Mackenzie,
Corps of Engineers, U. S. A.

U 7.

IMPROVEMENT OF HARBOR AT ROCK ISLAND, ILLINOIS.

No project was made for the expenditure of the appropriation of
6,000 made by act of March 3, 1881, as other work of greater impor-
ance occupied nearly all of the time of all the dredges on the river.
There was in addition to the above sum a balance of $1,360 available
rom the appropriation of June 14, 1880, and a portion of this sum was
sed in removing obstructions from along the city wharf. An agree-
nent was made with Whitney & Son for the use of one dredge at $10
er hour.
Between August 30 and September 5, 1881, material was removed to
he amount of 407 cubic yards, and at a cost of $690.
There still remains available for use on this improvement the sum of
6,669.62, which will be used as circumstances may justify.
No further amount is asked for fiscal year ending June 30, 1884.

COMMERCIAL STATISTICS OF ROCK ISLAND, ILLINOIS FOR 1880.

		Tons.
Receipts by river		34,942
Shipments by river		12,062
Total carried		47,004
Lumber manufactured	feet..	70,774,778
Shingles manufactured	pieces..	7,870,500
Laths	do....	13,135,000
Pickets	do....	296,475

There passed Rock Island Bridge during season of 1881, 2,711 steamboats, 449 barges,
and 953 rafts.

ABSTRACT OF APPROPRIATIONS.

By act approved June 14, 1880	$6,000
By act approved March 3, 1881	6,000
Total	12,000

Money statement.

July 1, 1881, amount available	$7,359 6
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	690 0
July 1, 1882, amount available	6,669 6
Amount (estimated) required for completion of existing project	14,759 1

U 8.

IMPROVEMENT OF MISSISSIPPI RIVER AT ANDALUSIA, ILLINOIS.

The original project for this work as contained in my report of December 17, 1880, contemplates—

1. The construction of a dam (No. 1) from Illinois shore to Island 32
2. Protection of Island 321 for about 900 feet.
3. Construction of a dam (No. 2), with necessary shore protections, between Islands 320 and 321.
4. Construction of a dam (No. 3) between Islands 319 and 318.

Prior to commencement of construction a thorough examination of the locality was made, and it was deemed advisable to begin only that part of the work which the funds available, $6,000, would be sufficient to complete. Accordingly the work consisted in protecting the head of Island 321, and constructing Dam No. 2, between Islands 319 and 32 Operations were begun August 8, 1881, and completed September 1881; the work being done under contract with Whitney & Son, of Keokuk, Iowa, at a price of $1.85 per cubic yard for rock, and $1.2 per cubic yard for brush.

ISLAND 321.

The head of this island was protected by a strong revetment of brush and stone for a length of 510 feet, the riprap being carried up the slope of the bank from 15 to 20 feet.

DAM NO. 2, ISLAND 319 TO 320.

This dam, 483 feet in length, composed of alternate layers of brush and rock, was completed to a height of 3 feet above low water, the shores at each end being well protected by riprap.

COST OF WORK.

2,006.9 cubic yards rock, at $1.85	$3,712 7
1,270.4 cubic yards brush, at $1.25	1,588 0
Engineering and contingencies	83 9
Total	5,384 6

On account of the destruction of the warehouses at Andalusia by ice in the winter of 1880 and 1881, very little shipping was done in 1881.

ABSTRACT OF APPROPRIATIONS.

By act approved March 3, 1881	$6,000

Money statement.

July 1, 1881, amount available	$5,960 45
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	5,384 66
July 1, 1882, amount available	575 79
Amount (estimated) required for completion of existing project	12,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	12,000 00

U 9.

IMPROVEMENT OF HARBOR AT MUSCATINE, IOWA.

At the time of my last annual report work of dredging in the harbor was being carried on under agreement with Whitney & Son, at a price of 20 cents per cubic yard, and was continued until July 14, 1881.

The dredging was principally done at mouth of Papoose Creek and along the city wharf.

Under the appropriation of $7,500, of June 14, 1880, the agreement was made with Whitney & Son, and as the amount, $2,500, appropriated by act of March 3, 1881, was too small to justify advertising for proposals, this agreement was extended to cover the latter appropriation.

The total amount of material removed under these two appropriations between October 11, 1880, and July 14, 1881, amounts to 42,124 cubic yards.

SUMMARY OF WORK.

18,294 cubic yards material dredged, at 20 cents	$3,658 80
Engineering and contingencies	277 43
Total	3,936 23

The work has thus far proved very successful, the current at present sweeping along the wharf and preventing deposits.

Money statement.

July 1, 1881, amount available	$4,356 49
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	3,936 23
July 1, 1882, amount available	420 26
Amount appropriated by act passed August 2, 1882	2,500 00
Amount available for fiscal year ending June 30, 1883	2,920 26
Amount (estimated) required for completion of existing project	1,750 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	2,500 00

COMMERCIAL STATISTICS.

Lumber manufactured	feet	75,000,000
Lath	pieces	23,000,000
Shingles	do	20,500 000
Pickets	do	85,000
Doors		65,000
Blinds	pair	35,000
Windows		95,000

Shipments by river:

General merchandise	packages..	39,
Apples	barrels..	
Sweet potatoes	do....	14
Oatmeal	packages..	7,
Stock	head..	
Washboards	dozen..	
Wagon brakes	bundles..	3,
Canned goods	cases..	7,
Melons	No...	120,
Flour	barrels..	
Potatoes	sacks..	2,
Grain	bushels..	250,
Hay	bales..	1,

Receipts by river:

Stock	head..	
Merchandise	packages..	72,
Flour	barrels..	2,
Oil	do....	
Lime and cement	do....	2,
Agricultural implements	packages..	5,
Lumber	feet..	25,

ABSTRACT OF APPROPRIATIONS.

By act approved March 3, 1879	$7,
By act approved June 14, 1880	7,
By act approved March 3, 1881	2,
Total	17,

U 10.

IMPROVEMENT OF HARBOR AT FORT MADISON, IOWA.

No work of construction was done during the fiscal year.

In the early part of September, 1881, a survey was made and a pr ject submitted on September 16 asking authority to expend the $2, available under act of March 3, 1881, and such an allotment as mig be necessary from appropriation for improving Mississippi, "Saint Pa to Des Moines Rapids," for continuing protection of Niota Island, pr tecting head of Island 393, and laying a course of stone and brush fro Island 392 to 393 to prevent further scour in the chute between th islands. Authority was also requested to make an informal agreeme with private parties for performing the work. This authority was grant by letter of September 28, 1881, and bids were asked for, but being e cessive were rejected.

It is proposed to carry out the above project the present season, eith by hired labor and use of the public plant, or by agreement, if reas able terms can be procured.

Fort Madison is unfortunately situated in a deep bend of the rive and extensive works commencing some distance above the city will b required to maintain a channel along its front. This work should b commenced during the present season, but can only be accomplish by adding to the small appropriation now available a large allotme from the general appropriation for improving the Mississippi Rive Saint Paul to Des Moines Rapids.

Money statement.

July 1, 1881, amount available	$2,500 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	225 75
July 1, 1882, amount available	2,274 25
Amount (estimated) required for completion of existing project	6,086 87
Amount that can be profitably expended in fiscal year ending June 30, 1884.	6,100 00

COMMERCIAL STATISTICS OF CITY OF FORT MADISON, IOWA, FOR 1881.

Lumber manufactured	feet..	28,000,000
Shingles	pieces..	36,000,000
Lath	do....	11,000,000
Other manufactures	value..	$1,000,000

The amount of grain shipped was, in 1881, 1,350,000 bushels, and of timothy seed 68,750 bushels.

ABSTRACT OF APPROPRIATIONS.

By act approved August 14, 1876	$10,000
By act approved June 18, 1878	8,000
By act approved March 3, 1879	3,600
By act approved March 3, 1881	2,500
Total	14,100

U II.

IMPROVEMENT OF DES MOINES RAPIDS, MISSISSIPPI RIVER.

This work was in charge of Maj. Amos Stickney until November 21, 1881, at which date I relieved him by virtue of Special Order No. 241, dated October 26, 1881. Mr. R. R. Jones, assistant engineer, who had been connected with this work for many years, resigned his position January 1, 1882, and the immediate charge of operations was given to Mr. M. Meigs, United States civil engineer, to whose appended report I would refer for details of the past year. The work of the year consisted in blasting and dredging 1,332 cubic yards of rock from the cuts through the chains between Nashville and Montrose, and the laying of 352 cubic yards of riprap stone for the protection of the canal embankment. The extreme high water of the year, which interfered with the working of the steam drill and dredge, and the failure of the contractor for furnishing riprap rock, have greatly reduced the amount of work which would have been accomplished under ordinary circumstances.

A new contract for furnishing 6,000 cubic yards of riprap rock for canal embankment was let to Patterson Brothers, of Keokuk, Iowa, on June, 1882, and delivery has already commenced. It is proposed with the balance now available, and whatever funds may become available in 1882, to continue the removal of rock from the channel of the rapids above the canal, and the protection of the canal embankment by purchasing and laying riprap face stone; to repair the cribs marking the channel, and build two additional ones at the upper entrance to the canal; to inaugurate the raising of the walls at the middle and lower locks, and to make such necessary repairs to plant as may be required.

The experience gained since the canal has been in operation has shown the necessity and advantages to be derived from raising the canal and wing-walls at the middle and lower locks. The plan which is now submitted is to raise the lock and wing-walls of lower lock, 4 feet above present coping and to raise the upper half and wing-walls of middle lock to the same height. This improvement will permit the carrying of more water in the canal, thus adding to the speed and safety of navigation through it. It will afford a means of protecting the suspension columns and machinery for running lock gates, and coping of walls, which are now liable to be damaged or destroyed at any time. It will greatly facilitate the entrance to the canal locks, and do away with the dangers and delays now constantly occurring, owing to guards of steamers riding over and catching on the irregular surfaces and projections of wing-walls. This raising of the walls is also of great importance in prolonging the time during which boats can use the canal; at the present time they frequently are compelled to pass over the rapids at stages when there is much risk attending such a trip. The estimated cost of the raising of lock and wing-walls at middle and lower locks is $52,745, and of this amount $16,000 has been included in former estimates, leaving a balance of $36,745, which amount is added to the previous estimates for completing this work. An item of $5,000 is also added to former estimates for building two additional cribs at the upper entrance to the canal, which are demanded in the interest of safe navigation, and for repairing the cribs on the rapids, which are of importance as channel marks.

The close proximity of the Keokuk Bridge to the foot of the Des Moines Rapids Canal has proved a source of danger to steamers at stages when they are compelled to descend the rapids. A solid crib connecting the foot of the outer canal wall with the long pier of the bridge would greatly lessen this danger.

A dry-dock built as an adjunct to the canal would be of invaluable service, not only in connection with the construction and repair of the boats and barges belonging to the United States, but for the general public.

Money statement.

The amount expended to June 30, 1882, or construction of improvement $4,332,907.19.

July 1, 1881, amount available	$44, 568 3
Amount received from sale of fuel to officers	19 1
	44, 587 4
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	14, 340 2
July 1, 1882, amount available	30, 247 1
Amount appropriated by act passed August 2, 1882	30, 000 0
Amount available for fiscal year ending June 30, 1883	60, 247 1
Amount (estimated) required for completion of existing project	96, 745 0
Amount that can be profitably expended in fiscal year ending June 30, 1884	97, 000 0

Abstract of proposals for furnishing stone for riprap canal embankment received in response to advertisement dated May 14, 1881, *and opened June* 15, 1881, *by Maj. Amos Stickney, Corps of Engineers, at Keokuk, Iowa.*

Number of proposals.	Names of bidders.	Articles to be furnished.	Quantities.	Price per cubic yard.	Delivery.	Remarks.
1	Tallant Marble and Stone Company.	Stone.	6,000 cubic yards more or less.	$2 34	1,000 to 2,000 cubic yards per month.	Lowest responsible bidder.
2	W. A. & J. C. Patterson	Stone.	6,000 cubic yards more or less.	2 95	1,000 cubic yards per month or faster if required.	

Abstract of all proposals received and opened this 8th *day of June,* 1882, *by Maj. A. Mackenzie, Corps of Engineers, for furnishing* 6,000 *cubic yards of stone for riprap face at the Des Moines Rapids Canal, Mississippi River.*

No.	Names and residences of bidders.	6,000 cubic yards of stone.		Remarks.
		Per cubic yard.	Amount.	
1	Patterson Brothers, Keokuk, Iowa	$3 00	$18,000	Written contract made.
2	Peterson & Schrader, Rock Island, Ill., Glen Haven, Wis.	3 27½	19,650	Informal.
3	Whitney & Son, Keokuk, Iowa	3 25	19,500	
4	H. S. Brown & Co., Quincy, Ill	4 00	24,000	

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

KEOKUK, IOWA, *June* 30, 1882.

MAJOR: I have the honor to submit the following report on improving Des Moines Rapids, Mississippi River.

This work during the past year has been carried on as formerly by drilling and blasting and dredging rock from the cut 200 feet wide through the "chains" above Nashville and below Montrose, Iowa.

This distance, 3¼ miles, has been pretty well worked over and the worst obstructions removed, but there is still a considerable amount of rock in the channel which is above grade, and which must be removed to secure a 5-foot channel at low water.

The United States steam drill scow and steam dredge have been exclusively used on this work.

A great portion of the rock excavated has been towed into the canal and used for dressing the slopes of the canal embankment, preparatory to laying riprap face walls. This has been a great saving in cost, as were the rock to be bought for this special purpose, it probably could not be had for less than 75 cents per cubic yard.

Both dredge and drill boat were at work from July 1 to October 14, 1881, when they were driven off the rapids by the high water.

The dredge boat was put in commission again February 28, 1882, and the drill boat March 11, 1882. Both boats were driven in by high water April 24, from which time no work has been done on the rapids.

Advantage was taken of the time the drill boat was laid up to connect her capstans with the shaft of the portable engine and boiler used to drive the machinery of the drills. The dredge also had slight repairs made—a new hoisting chain, &c.

The work on the rapids has been greatly interfered with during the past season by reason of high water and windy and wet weather, which made progress slow, and which has proved a very unfavorable year for work on river improvements generally.

Both drill and dredge were moved about and worked in many places at different times.

The work of the season extended from the foot of Montrose Chain to the foot of Nashville Dam No. 2.

The following is a statement of the amount of work accomplished:

Work accomplished with drill-boat.

Month.	Number of holes drilled.	Total depth drilled.	Number of pounds of dynamite No. 2.	Number of fuses.	Number of cubic yards blasted.
		Feet.			
July, 1881	440	1,036	747	440	2
August, 1881	331	810	604	331	1
September, 1881	610	1 576	1,160	616	5
October, 1881	128	321	323	128	6
March, 1882	256	640	504	257	1
April, 1882	272	712	462	261	3
Totals	2,037	5,095	5,798	2,033	1,1

Work accomplished with dredge and drill.

Date.	Area drilled over.	Amount of blasted rock dredged.	Amount of chiseled rock dredged.	Area made available for navigation.
	Sq. ft.	*Cu. yds.*	*Cu. yds.*	*Sq.*
July, 1881 to January, 1882	18,448	6.48	268	44
March, 1882	3,750	4.16	....	44
April, 1882	1,479			
Totals	23,677	10.64	268	8

RIPRAPPING THE CANAL EMBANKMENT.

The contractors for stone for this work (the Tallant Marble and Stone Company, Muscatine, Iowa), under contract dated July 13, 1881, proceeded but very slowly in its delivery. During August and September they actually furnished but 352.6 cub yards instead of a minimum of 2,000 cubic yards to be furnished in that time as spe- fied. March 7, 1882, the contractors formally expressed their intention of relinquis- ing their contract, and a new contract was rendered necessary.

June 9, 1882, a new contract was signed (after the usual advertisement) with th Patterson Brothers, of Keokuk, Iowa, to furnish 6,000 cubic yards from the Son Quarry, Illinois, at $3 per cubic yard.

It is hoped and believed that this stone will be delivered promptly.

CRIBS ABOVE THE CANAL.

During the past winter and during the high water of the past spring great damag has been done to the guiding piers of wood and stone situated at various points alo the river channel between Nashville and Montrose. Some of these are used by th Light-House Department for their lights, and all are important as making out acc rately the narrow channel excavated through the rocks. It will cost a very consid able sum to repair them.

The two cribs 18 feet square built above the guard-lock during the winter of 1880- have been found very useful in facilitating the approach to the entrance of the cana but universal demands are made for an extension of this line of piers, as there is n room enough for a steamer and tow to lay against them.

Two more cribs should be built on the same line, but somewhat heavier, as th 18-foot cribs are found to shake badly under the heavy strains put upon them. Th work properly belongs to "operating and care of the canal," but they have hither been built out of funds for improving Des Moines Rapids.

The cost will be, repairs to cribs above Nashville	$1,0
Two new cribs at Nashville 25 feet square	4,0
	5,0

RAISING LOCK WALLS 4 FEET.

On June 22 I submitted an estimate for raising the lock walls so as to allow of carrying more water in the canal, and also for preventing damage to the lock machinery now frequently exposed to destruction by the overhanging guards of steamers which overlap the walls. This estimate, if approved, as well as that for repairs of cribs and piers, and building new piers at Nashville, should be added to any previous estimate for completing the Des Moines Rapids Canal. The estimates above referred to are repeated here as follows:

ESTIMATE FOR RAISING LOCK WALLS OF THE DES MOINES RAPIDS CANAL, AND FOR CRIBS ABOVE CANAL.

Repairs of cribs and piers above canal	$1,000
Two new cribs 25 feet square at entrance	4,000
Raising upper half lock walls middle lock	10,425
Raising whole length lock walls lower lock	20,850
Raising wing-walls below lower lock	21,470
	57,745
Deduct former estimate of Major Amos Stickney for raising part of lock walls 3 feet	16,000
Total sum to be added to former estimates	41,745

Mr. C. P. Comegys and Mr. C. M. Bennett have rendered me most valuable assistance both in the office and in the field, and to them as well as to the other employés on the work my thanks are due for both zeal and efficiency in their various duties.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

U 12.

OPERATING AND CARE OF DES MOINES RAPIDS CANAL.

By virtue of Special Order No. 241, dated October 26, 1881, I relieved Maj. Amos Stickney, Corps of Engineers, who was in charge of this work previous to that date. Mr. M. Meigs, United States civil engineer, was placed by me in immediate charge of the work, relieving Mr. R. R. Jones, who had resigned his position. In connection with the management of the canal I would refer to Mr. Meigs' appended report for details of the past year's work. During the year the canal has been operated in the interest of navigation at such times as the stage of water necessitated and permitted its use, but the remarkable and long continued high stage of water enabled boats to run the rapids for a much longer space of time than is usual, 760 steamboats and 444 barges, carrying 8,588 passengers, 29,043 tons of general merchandise, and 781,817 bushels of grain, and 15 rafts containing 17,150,011 feet of lumber, 4,475,000 feet of logs, and carrying 4,885,250 shingles, and 311,282 lath, were passed through the locks, requiring 2,292 lockages at the middle lock. The extreme high water developed a number of leaks in the canal embankment, and a small force has been kept at work the entire season in making repairs. It is hoped the stone revetment can be soon completed, that the necessity of continually repairing the bank may be done away with. The canal being much obstructed with the accumulated deposits of many years a contract was made in July, 1881, with H. S. Brown to remove 40,000 cubic yards, and in June, 1882, a second contract with Whitney & Son to remove 100,000 cubic yards. The canal dredge has also been employed in the canal when high water prevented work outside on the rapids. A careful survey of the canal made in April, 1882, showed that at that date there was in the canal over 200,000 cubic yards of deposited material requiring removal. It is very necessary that the canal be thoroughly cleaned out, or navigation may become troublesome. When the great accumulation is once removed the canal dredge alone will be able to take out material as rapidly as deposited. For the protection of the gate machinery, &c., four timber cribs filled with stone were placed on the lower lock walls. It is hoped that these temporary structures may be soon replaced by masonry. To facilitate repairs which are being continually required not only for canal machinery and appliances, but also for the machinery of boats, &c., used in connection with river improvement, a small shop has been established at the canal.

It is hoped the electric light may soon be introduced for illuminating the walls and gates, thereby facilitating navigation at night. The expense of operating, and care of canal during past year, including the dredging contract with H. S. Brown, has been $53,661.27, of which amount $8,288.48 is still outstanding. Total amount expended to June 30, 1882, for above purpose, $199,336.17. The future expenses of the canal are provided for in the act of March 3, 1881, which authorizes the Secretary of War to draw from the Treasury from time to time such amounts as may be needed.

Abstract of proposals for dredging in the Des Moines Rapids Canal, received in response to advertisement dated June 4, 1881, *and opened July* 5, 1881, *by Maj. Amos Stickney, Corps of Engineers, U. S. A., at Keokuk, Iowa.*

No.	Name of bidder.	Work to be done.	Quantities.	Price per cu. yd.	Daily capacity.
1	Whitney & Son	Dredging	About 40,000 cubic yards	$0 35	600 cubic yards.
2	H. S. Brown*	do	do	33¼	500 cubic yards.

* Lowest responsible bidder.

Abstract of all proposals received and opened this 8*th day of June,* 1882, *by Maj. A. Mackenzie, Corps of Engineers, U. S. A., for dredging* 100,000 *cubic yards of material in the Des Moines Rapids Canal, Mississippi River.*

No.	Names and residences of bidders.	100,000 cubic yards material.		Remarks.
		Per cubic yard.	Amount.	
1	Whitney & Son, Keokuk, Iowa	$0 29¾	$29, 750	Written contract made.
2	H. S. Brown & Co., Quincy, Ill	30	30, 000	

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

KEOKUK, IOWA, *June* 30, 1882.

MAJOR: I have the honor to submit the following report on operating and care of Des Moines Rapids Canal:

The high water that closed the last fiscal year has been continued nearly through the whole navigable period of the present one. The lower lock gates, which are only thrown open at very high water, have been opened as follows:

July 1 to July 15, 1881	Closed.
July 15 to July 21, 1881	Open.
July 21 to October 8, 1881	Closed.
October 8 to December 1, 1881	Open.

March 6 to April 19, 1882	Closed.
April 19 to May 18, 1882	Open.
May 18 to May 27, 1882	Closed.
May 27 to June 7, 1882	Open.
June 7 to June 11, 1882	Closed.
June 11 to June 14, 1882	Open.
June 14 to June 26, 1882	Closed
June 26 to June 30, 1882	Open.

The canal was closed to navigation on account of high water October 17, 1881, the water being over the lock walls, and it remained closed to December 1, when the water was drawn off and the machinery dismantled for the winter. March 6, 1882, the canal was reopened for day navigation only, as there were few boats running, and March 20, 1882, the day and night crew were both put on, and the season regularly opened.

The winter was a very mild one, the thickest ice on the canal being not over 9 inches at any time, and the river not closing at all.

The highest water was reached October 29, 1881, when the gauge at the head of the canal recorded 11.30 and that at the foot 18.95 feet above low water of 1864. This is 1.45 feet higher at the foot of canal than any stage attained since the canal was opened, and 1.98 feet only below the extreme high water of 1851. In places the water rose to within a few inches of the top of the canal embankment, and gangs of men were kept at work stopping leaks, when discovered, and protecting temporarily the unfinished slopes of the bank. A good many leaks were discovered which owed their existence to loose rock in the embankment, and this has necessitated extensive trenching and refilling.

REFILLING AND REPAIRING THE CANAL EMBANKMENT.

During the entire working season a force of fifteen to twenty men has been kept at work refilling the bank, raising it to grade where it had settled (in places 2 feet and more), and protecting and filling the slopes with loose rock excavated by the United States dredge above Nashville.

On the lower level the bank has been raised to grade throughout, though it is still in places too narrow.

About 2,500 feet of the embankment was ditched, the loose rock removed, and the trench refilled with earth rammed and carefully compacted. The earth for this purpose was mostly taken from a point of land outside of the middle lock.

DREDGING IN THE CANAL.

Under a contract dated July 20, 1881, for about 40,000 cubic yards, at 33⅓ cents, Mr. H. S. Brown, of Hamilton, Ill., began dredging August 17 at the lower entrance to the canal, and worked at this place up to August 14, when his fleet was removed to the upper level, and continued dredging accumulations of deposits about the mouths of Price's and Lamallee's creeks.

April 4 a single cut was begun at section 76, below the guard lock, which was completed April 7, and this completed, also, the contract, which had already a little overrun the specified 40,000 cubic yards.

Mr. Brown's contract accomplished the following:

STATEMENT.

	Cubic yards.
Mouth of Price's Creek, well cleaned out	210.44
Lamallee's Creek, two cuts from section 46-54	85.70
Below guard lock, one cut from section 76-79	12.00
Lower entrance to canal cleaned	108.73
Total cubic yards	416.87

(Price, 33⅓ cents.)

Under contract dated June 9, 1882, for removing 100,000 cubic yards, at 29¾ cents per cubic yard, from the prism of the canal, Messrs. Whitney & Son began work on the Sandusky Reach (section 41 to 54) June 15 with two dredges and a large fleet of dump-boats and tugs.

The dredging accomplished to the end of the fiscal year June 30 is all in the vicinity of the mouth of Lamallee's Creek.

Total excavated to June 30, 8,072 cubic yards.

The United States dredge and tow-boat No. 4 have been at work in the canal since May 8, 1882, removing deposit from the upper entrance to the canal and from the canal prism. The work accomplished is as follows:

	Cubic yar
Sandusky reach, section 50–53	13,0
Below guard lock (one cut), section 76–9	1,0
Above guard lock	3,9
Total cubic yards removed	18,0

The following summary shows the amount of material removed during the fisca year:

Statement of dredging done during the fiscal year ending June 30, 1882.

By whom.	Cubic yards removed from—					
	Below lower lock.	Price's Creek.	Sandusky.	Below guard lock.	Above guard lock.	Total.
H. S. Brown	10, 873	21, 044	8, 570	1, 200	....	41,
United States dredge	....	....	13, 031	1, 036	3, 964	18,
Whitney & Son	....	....	8, 072	....	....	8,
Total	10, 873	21, 044	29, 673	2, 236	3, 964	67,

SURVEY.

A careful survey of the canal was made with soundings in April. Permanent numbers were placed on the embankment, dividing the canal into sections 500 feet long, zero being at the upper column of the lower lock. A line of levels was run over the embankment for determining the places requiring to be filled, and to determine the high water slope accurately, stakes having been driven at the highest point attained in October, 1881, at every half mile.

An estimate was made from the survey of the amount of sediment in the canal on April 6, 1882, which was as follows:

Estimate of sediment in the Des Moines Rapids Canal April 6, 1882.

Locality.	Section to section.		Material above grade.	Above sub-grade.	Total.
			Cubic yards.	*Cubic yards.*	*Cubic yard*
Upper level	25	79	136, 942	46, 587	183,
Lower level	0	25	28, 170	....	28, 1
Totals	....	....	165, 112	46, 587	211.

It will be seen that the dredging in the canal has fallen far in arrears, and unless a wholesale removal of the deposits is made great obstructions to the use of the canal will continue.

During May and June, 1882, frequent and violent storms added many thousand cubic yards to the deposits, possibly as much as has been taken out this spring, or about 16,000 cubic yards; at least the dredges have seemed to gain but little on the encroaching bars. With the prism of the canal once thoroughly cleaned, a single dredge will have but little trouble in removing the annual accretions for many years again.

REPAIRING FLAT-BOATS, DREDGE, &C.

A force of men has been employed occasionally finishing repairs to the fleet belonging to the canal and not completed last season. Dump-boat No. 2 has been hauled out and thoroughly repaired, and sundry occasional repairs made on No. 1. The steam-launch has been put in fair condition, but is too small for general work in the canal, and draws too much water. She should be replaced by a larger boat which could be run at the same expense and do more work.

REPAIRS TO LOCK MACHINERY.

No very extensive repairs were found necessary during the past year. The boiler at the guard lock was jacketed with wood and Russia iron, accomplishing a considerable saving in fuel.

New leathers were put in the various hydraulic cylinders when found necessary, the engines at the middle and lower locks were repainted, and the distributing valves cased with Russia iron.

After the water was drawn off in December a small coffer-dam was put in between the wing-walls at the lower end of the middle lock and the water pumped out. The housing of the chain sheaves at the bottom of the west lower gate was replaced, and swivels for suspending the gates overhauled and trimmed up to a good bearing.

CRIBS ON LOCK WALLS.

For the temporary protection of the machinery until the raising of the lock walls can be accomplished, four cribs were built in February and March, 1882, on the lock walls at the upper end of the lower and middle locks. These are 5 feet high, 20 feet long, and 10 feet wide. They have answered their purpose very well, and four should also be built at the lower end of the lower lock, where the machinery is very much exposed at high water.

MACHINE SHOP.

During the month of June the old tool-house near the middle lock was removed to the lower lock, and the building formerly occupied as a tool-house was converted into a machine shop. Two lathes, a drill press, and emery grinder, and an assortment of hand tools were bought for general repairs of the canal machinery.

One of the old portable engines used during construction of the locks furnished motive power. This shop will enable a large amount of the repair work to be done on the canal machinery, without having to depend upon outside shops, and with labor furnished by the regularly employed canal force during the winter months.

BUSINESS OF THE CANAL.

The long-continued high water during the past fiscal year has enabled a great proportion of the commerce to go outside of the canal, but it is noticeable that even during high water an increasing number of heavily laden craft prefer the security of the canal to the quicker but more dangerous channel over the rapids. An even greater number of boats would use the canal were it not for the shoal water in the canal and the delays caused by getting aground.

The canal should first of all be thoroughly cleaned out, then by raising the lock walls 4 feet an increased depth of water could be carried, and the machinery for operating the gates would no longer be subjected to the constant danger of destruction by overlapping steamboat guards, as is now the case whenever an attempt is made to carry more water in the levels than was originally provided for.

Traffic statement.

Month.	Steamboats.	Barges and flats.	Passengers.	Cargo.		Rafts.					Lockage at one lock.
				General merchandise.	Grains.		Rafts.	Logs.	Shingles.	Lath.	
	No.	*No.*	*No.*	*Tons.*	*Bushels.*	*No.*	*Feet.*	*Feet.*	*No.*	*No.*	*No.*
July	125	12	2,379	5,060	93,257		....	....	....	....	140
August	143	38	2,584	6,655	111,943	13	16,100,011	3,475,000	4,885,250	3,112,825	260
September	179	112	1,895	12,137	195,048	2	1,050,000	1,000,000	....	....	351
October	57	21	395	1,666	38,100	....	....	....	....	....	400
November	4	.....	15	725	50,854	....	....	....	....	....	191
March	51	186	118	2,740	94,660	....	....	....	....	....	115
April	80	42	279	4,395	161,981	....	....	....	....	....	151
May	60	15	270	4,005	19,427	....	....	....	....	....	233
June	61	18	653	1,660	16,547	....	....	....	....	....	451
Totals	760	444	8,588	29,043	781,817	15	17,150,011	4,475,000	4,885,250	3,112,825	2,292

Very respectfully, your obedient servant,

M. MEIGS.
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

U 13.

IMPROVEMENT OF THE MISSISSIPPI RIVER AT AND NEAR THE CITY OF ALEXANDRIA, MISSOURI.

The work projected under the appropriation of $6,000, made by act of March 3, 1881, was the completion of Dam No. 2, extending from Missouri shore about half a mile below the mouth of Des Moines River.

After due advertisement, contract was made with W. A. and J. C. Patterson, of Keokuk, Iowa, at $1.73 per cubic yard for rock and $1.23 per cubic yard for brush. Date of contract, May 20, 1881.

The work on Dam No. 2, the foundation of which was laid in 1880, was resumed August 3, 1881, and finished August 20. The crest of the dam was built to an elevation of 4 feet above low water at shore end and running down to 3 feet at outer end.

SUMMARY OF WORK.

1,756.39 cubic yards rock, at $1.73	$3,038 55
2,028.60 cubic yards brush, at $1.23	2,495 1
Engineering and contingencies	256 2
	5,789 9

ABSTRACT OF APPROPRIATIONS.

By act approved June 14, 1880	$10,00
By act approved March 3, 1881	6,00
Total	16,00

Money statement.

July 1, 1881, amount available	$5,964 1
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	5,754 0
July 1, 1882, amount available	210 0
Amount (estimated) required for completion of existing project	14,945 7
Amount that can be profitably expended in fiscal year ending June 30, 1884	15,000 0

U 14.

IMPROVEMENT OF NAVIGATION OF THE MISSISSIPPI RIVER AT QUINCY, ILLINOIS.

Under this head $25,000 was appropriated by act of June 14, 1880, and the project for its expenditure contemplated the use of $15,000 for the improvement of the river and $10,000 for dredging in Quincy Bay. At the time of my last annual report work of dredging in the bay was going on under the allotment of $10,000 above mentioned, H. S. Brown & Co., of Keokuk, Iowa, being the contractors.

The contract was completed July 14, 1881, the amount of material removed in July being 17,243 cubic yards. Total amount under the contract, 39,621 cubic yards.

Dredging during July, 1881, and for some time previous, was carried on above the bridge along the Illinois shore, and a large amount of material was dumped at high water in such a manner as to afford, when the water fell, some 1,600 feet of shore line well adapted for landing and unloading rafts.

An informal agreement had been made with H. S. Brown & Co. for closing Squaw Chute, which at high stages of the river brought considerable sand into the bay, thus rendering the results of dredging uncertain. This dam was begun in May, 1881, but was not completed until August 11, high water frequently interfering with and delaying the construction. It is 166 feet in length and is built to an elevation of about 10 feet above low water and with about 500 feet of shore protection at the ends of the dam and on the outside of the lower island.

Amount of material put in dam in July and August, 1881, 553 cubic yards rock, 224 cubic yards brush; total amount used in its construction, including shore protections: rock, 811.64 cubic yards; brush, 594.39 cubic yards.

The closing of this chute will be of great advantage in preventing large deposits of sand and mud being brought into the bay from the river at high stages.

Late in 1881 surveys of the bay and of the river in vicinity were made by Mr. W. A. Thompson, inspector, and the maps indicate great improvement in the channel crossing opposite the city, and the dredged area in the bay shows little or no filling during the past year.

An attempt was made in February, 1882, to blow up and remove an old wreck lying at the mouth of the bay, but high water prevented its accomplishment for the time being.

SUMMARY OF WORK.

*32,861.31 cubic yards material dredged, at 18 cents	$5,915 04
553.40 cubic yards rock, at $1.45	802 43
229.39 cubic yards brush, at 90 cents	201 95
Surveys, work on wreck, engineering, &c	846 48
	7,765 90

It is proposed to expend a portion of the balance in hand for raising the ground and preparing site for public storehouse at lower end of the bay, for piling along lower end of island opposite proposed storehouse, for removing wreck above alluded to, and for dredging a small harbor for use of the government fleet.

As the work of improving the bay, which is very important as a winter harbor, will hereafter be carried on under the appropriation for improving Quincy Bay, no further appropriation is asked for under the head of improving navigation of Mississippi River at Quincy, Ill.

ABSTRACT OF APPROPRIATIONS.

By act approved March 3, 1879	$20,000
By act approved June 14, 1880	25,000
Total	45,000

Money statement.

July 1, 1881, amount available	$20,584 70
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	8,058 48
July 1, 1882, amount available	12,526 22

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* 15,615 yards dredged in June, 1881, but not paid for until July.

U 15.

IMPROVEMENT OF QUINCY BAY, ILLINOIS.

The project for this work is given in report of Chief of Engineers for 1879, page 1130.

The act of March 3, 1881, appropriated $10,000 for the improvemen of Quincy Bay, which had been hitherto carried on under allotments from appropriations for improvement of navigation of Mississippi Rive at Quincy, Ill.

It was proposed, with the money available at the beginning of th year, to continue dredging below the bridge on the west side of th bay, and to open a new channel from the deep water below the bridg to the various lumber yards, &c., on the east side.

This work was carried out under contract with H. S. Brown & Co-pany.

Details of the work are given in accompanying report of Assista Engineer C. W. Durham.

ABSTRACT OF APPROPRIATION.

By act approved March 3, 1881 .... $10,0

Money statement.

July 1, 1881, amount available	$10,000
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	10,000
Amount appropriated by act passed August 2, 1882	15,000
Amount (estimated) required for completion of existing project...........	154,109
Amount that can be profitably expended in fiscal ending June 30, 1884 ...	50,000

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1882.

MAJOR: I have the honor to present my annual report on improvement of Quin Bay, Illinois, for the fiscal year ending June 30, 1882.

There was appropriated for this work by act of March 3, 1881, the sum of $10,0 the whole amount of which was available on the 1st of July.

The contract for dredging was awarded to H. S. Brown & Co., at a price of 20 cen per cubic yard for material deposited at a distance of less than 1 mile, and 23 cen per yard for material deposited at a distance of more than 1 mile.

Operations commenced July 14, 1881, and continued until August 11. During th time the dredge worked on the bar above the bay bridge, in front of the lumber yar and saw-mill. The grade sought was 4½ feet below low water of 1864.

The channel dredged was about 140 feet in width and 1,900 feet long; 16,067 cub yards of material were taken out.

Work was resumed December 6, and continued until the 22d, during which ti 5,071 cubic yards were removed, partly from the bar at the entrance of the bay a partly from the bar below the bridge, adjacent to the island.

On the 13th of March the dredge resumed work on the bar at the entrance of th bay, and near the proposed site of the government depot.

By the 25th of March this bar was sufficiently improved to permit of steamboats be ing tied up at the island bank without danger of stranding; 4,721 cubic yards wer taken from this bar.

The dredge was then taken to the bar above the bridge, and worked at that point until April 29, 1882, when the contract was finished.

The results thus far obtained in the improvement of Quincy Bay are very gratifying, and large areas of deep water are now available for a winter refuge for steamboats and rafts.

SUMMARY OF WORK.

43,692.20 cubic yards material dredged, at 20 cents	$8,738 41
1,976.09 cubic yards material dredged, at 23 cents	454 50
Engineering and contingencies	807 09
Total	10,000 00

COMMERCIAL STATISTICS OF THE CITY OF QUINCY FOR 1881.

Volume of business transactions	$130,000,000
Ice cut for shipment by river, tons	173,000
Internal-revenue collections	$1,188,669
Freight received by rail, tons	564,320
Freight shipped by rail, tons	598,440
Received and shipped by river, tons	60,000

There passed through Quincy bridge in 1881 1,895 steamboats, 591 barges, and 396, rafts.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

U 16.

IMPROVEMENT OF THE MISSISSIPPI RIVER AT HANNIBAL, MISSOURI.

The original project for this work is given in Report of Chief of Engineers for 1880, page 1546.

Work was begun August 15, 1881, under appropriation of $20,000 made by act of March 3, 1881. The contract was awarded to H. S. Brown, at the following prices: Gravel dredged, per cubic yard, 50 cents; sand dredged, 20 cents; rock put in dam, per cubic yard, $1.56; brush, per cubic yard, $1. Operations ceased October 5 on account of extreme high water. Work was resumed May 26, 1882, and continued until June 27, when the funds for the purpose were exhausted. In 1881 dredging was done on the bar in front of and above the steamboat landing, the material being deposited on the wing-dam opposite the city; and to strengthen this dam and give a good foundation, 1,516.53 cubic yards of rock and 1,096.11 cubic yards of brush were used.

In 1882 dredging was done on the lower bar opposite mouth of Bear Creek, and along the levee below the steamboat landing. The material taken out was deposited on the wing-dam, which is now completed.

The work thus far performed has proved very beneficial; the principal obstructing bars having been removed and a strong current established along the river front of the city, which will go far to prevent further deposits.

SUMMARY OF WORK.

1,516.53 cubic yards rock, at $1.56	$2,365 78
1,096.11 cubic yards brush, at $1	1,096 11
19,247.12 cubic yards gravel, at 50 cents	9,623 56
30,465.23 cubic yards sand, at 20 cents	6,093 04
Surveys, engineering, and contingencies	914 90
Total	20,093 39

To Mr. W. A. Thompson much credit is due for faithful and intelligent supervision as inspector.

There passed Hannibal Bridge in 1881, 1,909 steamboats, 686 barges, and 322 rafts. The rafts contained about 370,000,000 feet of manufactured lumber and 24,000,000 feet of logs.

ABSTRACT OF APPROPRIATIONS.

By act approved June 14, 1880	$25,000
By act approved March 3, 1881	20,000
Total	45,000

Money statement.

July 1, 1881, amount available		$20,093 3
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$10,416 18	
July 1, 1882, outstanding liabilities	9,677 21	
		20,093 3
Amount (estimated) required for completion of existing project		15,000
Amount that can be profitably expended in fiscal year ending June 30, 1884		15,000

Commercial statistics of city of Hannibal, Missouri, for 1881.

Business.	Firms engaged.	Amount.	Car-loads.	Value.
Saw-mills ... feet, logs	1	15,000,000	1,500	$300,000
Lumber dealers ... feet	9	140,000,000	14,000	2,800,000
Lath	9	75,000,000	1,700	200,000
Shingles	9	50,000,000	700	175,000
Doors, sash, and blinds	10	....	100	150,000
Planing-mills	8	....	6,000	175,000
Lime ... barrels	3	250,000	2,000	200,000
Plaster and cement ... do	4	6,000	80	15,000
Hair ... pounds	4	300,000	20	60,000
Flour-mills ... barrels	3	123,000	1,200	900,000
Ice ... tons	10	80,000	6,000	150,000
Breweries ... barrels	3	5,000	70	40,000
Wagon and carriage shops	6	700	....	50,000
Soap factory	1	....	....	12,000
Pork packers ... pounds	4	4,000,000	....	375,000
Tobacco factories ... do	2	60,000	....	30,000
Cigar factories	7	2,000,000	....	60,000
Cooperage ... barrels	8	300,000	300	150,000
Salt ... do	1	250,000	3,020	350,000
Coal-oil ... do	1	200,000	3,500	1,200,000
Coal ... tons	2	64,000	4,200	225,000
Wood-yards ... cords	2	30,000	3,500	100,000
Wholesale groceries, &c ... sales	3	....	....	1,500,000
Retail establishments ... sales	500	....	....	2,225,000

U 17.

IMPROVEMENT OF MISSISSIPPI RIVER AT LOUISIANA, MISSOURI.

The original project for this work may be found in the Report of the Chief of Engineers for 1881, page 1723.

The work projected under the appropriation of $10,000 made by act of March 3, 1881, was the construction of Spur-dam No. 1, extending from the Illinois shore opposite the Louisiana elevator.

Work was begun June 26, 1881, the contract having been awarded to W. A. and J. C. Patterson, of Keokuk, Iowa, at a price of $1.93 per cubic yard for rock, and $1.28 per yard for brush.

Operations ceased on 27th July, the dam being then completed to a length of 1,000 feet, with its crest at an elevation of 9 feet above low water. It is very substantially built, being 35 feet broad at base and 15 feet on top, and graded up at shore end to meet the county road, so that, at low water stages, when the ferry-boat is unable to make its usual landings, the outer end of the dike may be used for that purpose.

Much credit is due to Mr. J. C. McElherne, the efficient inspector in charge of the work.

SUMMARY OF WORK.

Wing-dam No. 1:	
3,279.60 cubic yards rock, at $1.93	$6,329 63
2,086.23 cubic yards brush, at $1.28	2,670 37
Inspection and office expenses	1,000 00
Total	10,000 00

COMMERCIAL STATISTICS OF CITY OF LOUISIANA, MISSOURI, FOR 1881.

Louisiana, Mo., has a population of about 5,000, and is the principal city of Pike County. It is the second city of the State in the manufacture of tobacco, being surpassed in that respect by Saint Louis alone.

	Value.
Tobacco, manufactured	$670,000
Lumber, sales	1,950,000
Pickles, manufactured	75,000
Flour, manufactured	260,000
Wooden ware, &c	44,000
Ice	305,000
Banks, volume of business	9,450,000
Revenue collected	200,000
Mercantile business	10,150,000

There passed Louisiana bridge in 1881, 1,195 steamboats, 628 barges, and 114 rafts.

ABSTRACT OF APPROPRIATION.

By act approved March 3, 1881	$10,000

Money statement.

July 1, 1881, amount available		$9,951 62
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$9,322 06	
July 1, 1882, outstanding liabilities	629 56	
		9,951 62
Amount (estimated) required for completion of existing project		45,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		45,000 00

U 18.

IMPROVEMENT OF GALENA RIVER AND HARBOR, ILLINOIS.

The original project for this work is given in report of Chief of Engineers, 1874, page 289. The work of dredging under appropriation of $12,000 made by act of March 3, 1881, began on May 31, 1881, under contract with Whitney & Son, of Keokuk, Iowa.

Operations were prosecuted vigorously until September 10, when work was discontinued, the appropriation having been expended.

Summary of work to date.

Year.	Working season.	Excava
		Cubic y
1878	September 16 to November 17	
1879	April 3 to August 1	
1880	April 17 to August 13	
1881	June 1 to September 10	
	Total	

Details of the work are given in accompanying report of Mr. M. Mei United States civil engineer.

ABSTRACT OF APPROPRIATIONS.

By act approved June 18, 1878	$30,
By act approved March 3, 1879	12
By act approved June 14, 1880	12
By act approved March 3, 1881	12
	66,

Money statement.

July 1, 1881, amount available	$16,41
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	16,41
Amount (estimated) required for completion of existing project	334.0
Amount that can be profitably expended in fiscal year ending June 30, 1884	50,0

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 18

MAJOR: I have the honor to present my annual report on improvement of Ga River and Harbor, Illinois, for fiscal year ending June 30, 1882. Work of dredg under contract with Whitney & Son, began May 31, 1881. The prices for dredg were as follows: For depositing material at a distance not exceeding one mile cents per cubic yard; not exceeding 2 miles, 22 cents; 3 miles, 25 cents; 4 miles cents; 5 miles, 32 cents; 6 miles, 37 cents; 7 miles, 42 cents; 8½ miles, 49 cents.

Between May 31 and June 30 a cut was made from the woolen mill to a point feet below, which was within 600 feet of the cut made in 1879.

June 30 to July 25 the dredge made a single cut up stream to a point 200 feet ab the woolen mill, finishing a through cut 4½ feet deep at low water from the cut-of the railroad bridge. The cutting in the upper part of the river has been extrem heavy, 5 to 6 feet in soft mud. The old cut below woolen mill was found to b filled up, and, indeed, two weeks after the dredge had passed over the ground, it filled up 2½ to 3 feet.

On July 25 the dredge was removed to the lower end of long reach, where she work extending a second cut up stream, until September 10, when operations were dis- tinued. In August the water fell so low that the dumping grounds in vicinity of cut-off were for a time not available, and to reach those near the mouth of the r some dredging had to be done over in the vicinity of Sprout's Lake, 1 mile above mouth. I regret that the stage of water was such after discontinuing work th resurvey of the whole river was impossible. This survey should be made before more dredging is done. The season as a whole was very favorable for the work. water being high nearly all the time and allowing the dumping of material gener in pockets above the cut-off. These are now so well filled up that for the future al everything will have to be towed out and dumped in the Mississippi. Perhaps so scheme could be devised to retain the mud within a channel, say 60 to 80 feet in wi by means of sheet piling, and a special machine constructed to take the material of the channel and deposit it behind the artificial walls of the canal. Such a sche would involve a large outlay of money, and would not be warranted by any such propriations as Congress has thus far seen fit to make for this improvement. Undou edly the dredging has done much good, and was the means, combined with a hi stage of water, of allowing an immense shipment of grain by barges and steam from the port of Galena during the summer and fall of 1881.

EXPENSE ACCOUNT.

51,358 cubic yards material dredged	$14,467 98
Surveys, inspection, and office expenses	1,944 12
	16,412 10

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF CITY OF GALENA, ILLINOIS, FOR 1881.

Receipts and shipments by river:		
Pork	pounds	10,403,298
Oats	do	31,910,000
Wheat	do	14,575,000
Corn, barley, potatoes, flour, and feed	do	2,346,000
Lead	do	1,834,610
Black jack and zinc oil	do	11,832,000
Lumber	feet	17,208,510

U 19.

IMPROVEMENT OF CUIVRE RIVER.

The work of dredging and removing snags, impending trees, &c., in Cuivre River under appropriations of June 14, 1880, and March 3, 1881, was completed prior to June 30, 1881, and described in my last report.

COMMERCIAL STATISTICS.

Shipments:	Value.
Wheat	$50,000
Corn and oats	4,000
Live stock	5,000
Logs	8,000
Receipts: Miscellaneous	15,000

ABSTRACT OF APPROPRIATIONS.

By act approved June 14, 1880	$2,000
By act approved March 3, 1881	5,000

Money statement.

July 1, 1881, amount available	$372 50
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	372 50
Amount appropriated by act passed August 2, 1882	5,000 00
Amount (estimated) required for completion of existing project	18,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	18,000 00

U 20.

TRANSPORTATION AND DISTRIBUTION OF RATIONS AND SUPPLIES TO THE SUFFERERS BY OVERFLOW OF MISSISSIPPI RIVER.

On March 13, 1882, the following telegram was received by me:

WASHINGTON, D. C., *March* 13, 1882.

Is the Barnard or any other steamboat under your control available for distribution of supplies to sufferers from overflow on the Mississippi River and tributaries? If so, communicate by telegraph with Colonel Beckwith, Subsistence Department, at Saint Louis, who is charged with the district. Answer.

WRIGHT,
Chief of Engineers.

My answer, on the same day, was:

> Barnard and one tow-boat available. Will communicate details to Colonel Beckwith.
>
> MACKENZIE, *Engineers.*

On March 15 I received the following letter of instructions from Colonel Beckwith:

> SAINT LOUIS, MO., *March* 14, 1882.
>
> SIR: I have just had a conference with your assistant, Mr. C. W. Durham. I especially request that you cause to be sent to me at this port the side-wheel steamer General Barnard, now at Keokuk, and also the steam tow-boat Coal Bluff, with some barges, all duly manned. I give you my vehement injunctions for the most immediate haste.
>
> Very respectfully, your obedient servant,
>
> A. BECKWITH,
> *Assistant Commissary-General.*
>
> Capt. A. MACKENZIE,
> *Corps of Engineers, U. S. A.*

The General Barnard and the Coal Bluff with two barges were immediately sent to Saint Louis and placed under Colonel Beckwith's orders.

The Coal Bluff and barges left Saint Louis March 23, with 1,689 barrels meal, 383 boxes bacon, 17 bales tents, and some miscellaneous freight; arrived at Vicksburg March 28. On the down trip supplies were left at New Madrid, Gayoso, Memphis, Helena, Chotard's Landing, and Vicksburg. The return trip to Saint Louis was accomplished by noon of April 7, at which time the boat and barges were returned to me by Colonel Beckwith. They were immediately taken to Quincy, Ill., and laid up.

The General Barnard made three trips, the first two to Helena, and the last to Vicksburg. She left Saint Louis on her first trip March 19, with about 250 tons of supplies, and arrived at Helena on the 21st; returning, reached Saint Louis March 25. On this trip rations were distributed at New Madrid, Memphis, Scanlan's Landing, and Helena.

On second trip left Saint Louis March 28, with 200 tons supplies; arrived Helena March 30; returning, reached Saint Louis April 3. On this trip rations were put off at Mound City, Cairo, New Madrid, Ashport, and Helena.

On third trip left Saint Louis April 4, with 350 tons supplies, and arrived at Vicksburg April 10; returning, reached Saint Louis April 16. On this trip supplies were put off at New Madrid, Tiptonville, Gayoso, Memphis. Commerce, Dillard, Coffin's, Delta, Friar's Point, Sunflower, Public Landing, Pushmataha, Australia, Concordia, Waxhaw, Terrene, Riverton, Neblett's, Stormville, Bolivar, Buck Ridge, Cat Fish Island, Eutaw, Stopp's, Easton, Mound's, Wilkinson's, Offutt's, and Vicksburg.

On April 17 the General Barnard was returned to me, and immediately sent to Keokuk and laid up in the canal.

The amount expended by me under resolution of Congress of March 11, 1882, was $10,457.28.

U 21.

SURVEY FOR A HARBOR OF REFUGE IN LAKE PEPIN, AT STOCKHOLM, WISCONSIN, AND LAKE CITY, MINNESOTA.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., February 13, 1882.

GENERAL: I have the honor to submit herewith a report on "survey for harbor of refuge in Lake Pepin, at Stockholm, Wis., and Lake City, Minn., made in accordance with your instructions, dated March 21, 1881.

Accompanying the report is a map* of the survey showing on a scale of $\frac{1}{4800}$ the localities in question, which are situated nearly opposite each other on the lake, and also giving a sketch of Lake Pepin, taken from our published map of 1878.

I also inclose copies of statements* made by parties interested in the navigation of the Mississippi River, concerning the amount of commerce to be benefited by proposed improvements, and the dangers and delays arising from want of due protection during prevalence of high winds and storms. The survey was made partly in November and partly in December, 1881, by assistants G. A. Marr and A. J. Stibolt.

Lake Pepin is a wide stretch of the Mississippi River, about 20 miles in length, from 1½ to 3 miles in width, and of an average depth of about 35 feet. There is little or no current. Lake City and Stockholm are situated about midway between its upper and lower ends, the former on the western shore, the latter on the eastern.

Storms and high winds are very frequent in the lake during the season of navigation, and its surface becomes very rough in even a moderate gale.

The boats used in navigating the Upper Mississippi, both for general passenger and freight business and for rafting logs and lumber, are necessarily, on account of shoal water in the river, of such light construction and small depth of hull that they are unfit for rough weather and waves, and are consequently subjected to frequent delays and occasional danger to life and property.

On the western side there are three gravel points extending into the lake, which afford partial protection to boats and rafts in stormy weather, when they are able to reach their shelter.

On the eastern side, which is generally a rocky shore, there is no safe landing place available during the prevalence of high northerly or southerly winds.

The value of merchandise annually transported through the lake is variously estimated at from $250,000 to $500,000, besides about 150,000,000 feet of logs and lumber. There are no good landings or piers where freight can be conveniently shipped, and there also being so much risk the cost of transportation is greatly increased.

The construction of a safe harbor at some middle point in the lake, as at Stockholm or Lake City, or both, would be of material benefit to the interest of navigation.

1. It would facilitate the loading and unloading of freight and diminish the risk of the same, thereby greatly lessening the cost of transportation; and,

2. It would afford a place of refuge for steamboats with or without tows, and rafts of logs and lumber when unavoidably caught in the lake in a storm. At present steamboats with rafts are often delayed for days at the head of the lake, being afraid to attempt the entire passage, which occupies from six to seven hours, when, were there a safe harbor midway, they could frequently take advantage of a lull in the gale and easily and safely make the half-way point.

The object desired can be best attained by building outside breakwaters, behind which steamboats and rafts can always find shelter; but in view of the great cost of such work built in deep water and the fact that no special good would result until its completion, it would seem advisable to furnish such relief as may be considered necessary by constructing piers from the shore to deep water, which, while immediately available as points for landing and of refuge for steamboats, are s ceptible of being extended as far as circumstances may in the fut warrant.

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* Omitted.

I submit below estimates for breakwaters 1,000 feet and 500 feet length at both Lake City and Stockholm. The plan of the propo structures is similar to that used in improving harbors in Lake Mic gan, and is adapted to resist the force of storms and floating ice.

AT LAKE CITY, MINNESOTA.

There is a long gravel point at this place jutting out into the la affording partial protection to steamboats, which are, however, liable be blown on shore and stranded, and rafts landing here are sometim broken to pieces. Lake City is not situated in the direct line of trav through the lake, but is an important shipping point for grain and oth produce, at which freight and passenger boats usually land on their w up and down the river.

PROJECT.

The project for this locality is to build a single breakwater extend directly out into the lake from a point near foot of Walnut street.

Estimates are given for breakwaters 1,000 and 500 feet in length.

ESTIMATE FOR 1,000 FEET BREAKWATER AT LAKE CITY.

(Average dimensions of crib, 50 by 30 by 30 feet.)

3,504,000 feet, B. M., pine lumber, at $25 per M	$87
27,352 cubic yards rock, at $1.25 per yard	34,
252,600 pounds iron bolts, at 5 cents per pound	12,
Superintendence and contingencies, 15 per cent	20,
Total for 1,000 feet breakwater	154

ESTIMATE FOR 500 FEET BREAKWATER AT LAKE CITY.

(Average dimensions of crib, 50 by 25 by 25 feet.)

1,200,000 feet, B. M., pine lumber, at $25 per M	$3
9,008 cubic yards rock, at $1.25 per yard	11
105,200 pounds iron bolts, at 5 cents per pound	5,
Superintendence and contingencies, 15 per cent	6,
Total for 500 feet breakwater	53

AT STOCKHOLM, WISCONSIN.

This point is in the direct line of travel through the lake, for b freight boats and those towing rafts, and is entirely unprotected fr northerly, southerly, and westerly winds. The landing place is q shallow, and, being also in a very exposed position, boats are genera unwilling to land and take freight unless the lake is perfectly smo

Stockholm has no railroad facilities, the nearest road on the east side of the lake being about 45 miles away, and several small villa and about 15,000 people would be greatly benefited by the propo improvement.

PROJECT.

The project for this locality is to build a single breakwater out i the lake from a point just above the lower warehouse.

ESTIMATE FOR 1,000 FEET BREAKWATER AT STOCKHOLM, WISCONSIN.

(Average dimensions of crib, 50 by 25 by 21½ feet.)

1,496,460 feet, B. M., pine lumber, at $25 per M	$37,411
14,048 cubic yards rock, at $1.25 per yard	17,560
176,580 pounds iron bolts, at 5 cents per pound	8,829
Superintendence and contingencies, 15 per cent	9,570
Total for 1,000 feet breakwater	73,370

ESTIMATE FOR 500 FEET BREAKWATER AT STOCKHOLM, WISCONSIN.

(Average dimensions of crib, 50 by 18¼ by 18¼ feet.)

772,560 feet, B. M., pine lumber, at $25 per M	$19,314
5,496 cubic yards rock, at $1.35 per yard	6,870
77,920 pounds iron bolts, at 5 cents per pound	3,896
Superintendence and contingencies, 15 per cent	4,512
Total for 500 feet breakwater	34,592

Very respectfully, your obedient servant,

A. MACKENZIE,
Captain of Engineers.

To the CHIEF OF ENGINEERS, U. S. A.

APPENDIX V.

PRESERVATION OF THE FALLS OF SAINT ANTHONY AND IMPROVEMENT OF THE MISSISSIPPI ABOVE THE FALLS—IMPROVEMENT OF CHIPPEWA AND SAINT CROIX RIVERS, WISCONSIN, AND OF MINNESOTA RIVER AND RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA—RESERVOIRS AT THE SOURCES OF THE MISSISSIPPI—CONSTRUCTION OF DAM AT LAKE WINNIBIGOSHISH.

REPORT OF CAPTAIN CHARLES J. ALLEN, CORPS OF ENGINEERS, BVT. MAJOR, U. S. A., OFFICER IN CHARGE. FOR THE FISCAL YEAR ENDING JUNE 30, 1882, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Preservation of Falls of Saint Anthony.
2. Mississippi River above the Falls of Saint Anthony.
3. Construction of lock and dam on Mississippi River at Meeker's Island, Minnesota.
4. Chippewa River, Wisconsin.
5. Saint Croix River, Minnesota and Wisconsin.
6. Minnesota River, Wisconsin.
7. Red River of the North, Minnesota and Dakota.
8. Lock and dam at Goose Rapids on Red River of the North.
9. Reservoirs upon the headwaters of the Mississippi River and its tributaries, including experimental dam at Lake Winnibigoshish.
10. Surveys for reservoirs at the sources of the Mississippi and its tributaries.

EXAMINATIONS AND SURVEYS.

11. The headwaters of the Cannon River in Minnesota, with a view that same may be added to the reservoir system of the Upper Mississippi.

ENGINEER OFFICE, U. S. ARMY,
Saint Paul, Minn., August 7, 1882.

GENERAL: I have the honor to submit herewith the annual reports upon the works and surveys under my charge for the fiscal year ending June 30, 1882.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

NOTE.—These reports having been prepared before the passage of the river and harbor act of August 2, 1882, the proposed application of the sums appropriated has not been stated.

In order, however, to present a true statement of funds available, the money statement attached to each report has been corrected so as to include the sums appropriated by the last act.

V 1.

PRESERVATION OF FALLS OF SAINT ANTHONY, MINNESOTA.

The appropriation made by act of Congress approved March 3, 1881, could not be applied to any great extent during the year on account of high-water generally prevailing.

About 100,000 feet, B. M., of timber were procured, and some few yards of rock quarried, with which to commence work by sinking a crib to prevent injuries to the toe of the apron in the angle; but purchasing beyond this was discontinued, as there seemed no probability of the water lowering sufficiently to enable the expenditure of $15,000 to be made with any good to result therefrom.

As usual, logs were run more or less over the government work, instead of through the sluice, for building which (the sluice) an appropriation was made by Congress by act approved March 3, 1879, the excuse for running the logs over the apron frequently being that the booms above broke under the weight of the logs.

According to my observations, the booms above have frequently broken just about the time the logs have been wanted. The log sluice gave general satisfaction at the time it was built, and would have fully answered had the mill company made their sluice through their own works at the point expected. To run the sluice further up might be done, at considerable further expense, so as to get the logs in belonging to the lower river, but I do not recommend any appropriation for this, the terms of the charter to the Minneapolis mill company requiring it to provide for the free passage of saw-logs over the Falls of Saint Anthony.

A permanent injunction was granted last March against the running of logs over the works instead of through the sluice.

One Joel B. Bassett and others last October began the depositing of immense masses of earth, rock, stone, and other materials in the channel of the Falls, as the easiest way to them of disposing of material excavated for the foundation of a mill. He was requested, then notified, to desist. Finally the case went into the hands of the United States district attorney, under whose action Mr. Bassett has made several inadequate attempts to remove the material, working at it for a few days or so, and then petitioning the United States attorney to have the case dropped. It is the most defiant piece of trespass I ever heard of, and I have requested the United States district attorney to push him until he makes good the wrong he has done. His spoil dumps closed up until lately, if not to date, the entrance to the log sluice, besides diverting nearly all the discharge of the river (the width of discharge being already too small from encroachments of the mills on the bed of the river) towards and into the angle on the easterly side of the apron, undermining and damaging the United States works to great extent, apparently. As soon as the water lowers sufficiently an examination will be made, the cost of the damage by Mr. Bassett's work estimated, and a special report be made.

The present Congress having made no appropriation, as yet, for the fiscal year ending June 30, 1883, nothing can be said as to work for the coming year, excepting that, as soon as the water lowers sufficiently, it is proposed to utilize the balance of the appropriation of March 3, 1881, in repairing damages so far as the money will go.

If the preservation of the Falls of Saint Anthony is still to be done by the United States, the sum of $50,000 (in addition to that asked for the

NTH

year ending June 30, 1883) should be available for the year ending June 30, 1884.

Original estimate for the present project	$529,726 31
Remaining to be appropriated	159,726 31
Amount expended to June 30, 1882 (including outstanding liabilities)	569,571 85

This work is in the collection district of Minnesota. The nearest port of entry is Duluth, Minn., at which place the revenue collected during the fiscal year ending June 30, 1882, amounted to $13,658.98.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING THE FALLS OF SAINT ANTHONY.

By act approved—	
July 11, 1870 *	$50,000
March 3, 1871 *	50,000
June 10, 1872 *	50,000
March 3, 1873 *	50,000
June 23, 1874	125,000
March 3, 1875	100,000
August 14, 1876	120,000
March 3, 1879 †	10,000
June 14, 1880 ‡	10,000
March 3, 1881 ‡	15,000
Total	580,000

Money statement.

July 1, 1881, amount available		$15,012 16
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$4,453 15	
July 1, 1882, outstanding liabilities	130 86	
		4,584 01
July 1, 1882, amount available		10,428 15
Amount appropriated by act passed August 2, 1882		25,000 00
Amount available for fiscal year ending June 30, 1883		35,428 15
Amount (estimated) required for completion of existing project		134,726 31
Amount that can be profitably expended in fiscal year ending June 30, 1884		50,000 00

COMMERCIAL STATISTICS, 1881.

Minneapolis (Falls of Saint Anthony) water-power.

The lowest volume of the Mississippi River at Saint Anthony yet measured is 3,168 cubic feet per second, viz, on the 9th of March, 1881.

The greatest fall which any of the mills are now able to use is not over 50 feet. This gives something like 13,500 horse-power permanently available at Minneapolis, if we base the permanency on the winter flow alone. The power could be greatly increased by the construction of storage reservoirs to equalize the flow of water, and the construction of canals and races to utilize a larger fall.

Flour, lumber, and miscellaneous manufacturing, &c.

The city of Minneapolis has obtained a world-wide fame within the past few years as a great manufacturing center. The product of its mills and factories, which may now be found all through this country and Europe, have given it a reputation as a progressive and growing city, which is second to none on the continent. Its prosperity rests on its great water-power, which is universally acknowledged to be the greatest in the world which has been put to practical use. Among its many industries the manufacture of flour stands pre-eminent.

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* These sums were used before the adoption of the present plan.

† For sluice-way through public works, &c.

‡ For repairs and contingencies, &c.

Around the Falls of Saint Anthony has sprung into life within the past few yea gigantic business unequaled in its extent, on the globe.

It is said that the millers of Minneapolis to a large extent control the flour inte of the country.

The maximum daily capacity of the flour mills at the Falls of Saint Anthony is s to be 25,750 barrels.

The export trade has been a very important factor in the milling business du the past year.

Great Britain afforded the first market for Minneapolis flour, and is still the ch one, but the trade at the present time extends into France, Germany, Holland, Spa Italy, Russia, and Africa.

The exports of flour to foreign ports from America up to December 1, 1881, accor ing to the report of the Secretary of the Treasury, made by the Chief of the Bure of Statistics at Washington, was 6,301,659 barrels, of which amount Minneapolis mi contributed nearly one-fifth.

The following table gives the shipments and exports of flour for the years named

Year.	Shipments.	Expo
	Barrels.	*Barr*
1860	30, 000	....
1865	98, 000	....
1870	93, 000	....
1873	585, 000	....
1874	727, 000	....
1875	843, 000	....
1876	1, 000, 675	....
1877	935, 544	....
1878	940, 786	[illegible]
1879	1, 551, 789	442,
1880	2, 051, 840	762,
1881	3, 143, 243	1, 2

Increase past year over preceding year, 508,937.

Lumber.

The season of 1881 has been one of the most prosperous that the manufacturers a dealers in lumber have known in many years.

The cut of lumber by the mills of Minneapolis was some 34,000,000 feet greater th in any former year, aggregating over 234,000,000 feet.

Comparative statement of lumber production for six years.

1881	feet..	234, 245,
1880	do...	195, 452,
1879	do...	149, 754,
1878	do...	130, 274,
1877	do...	129, 676,
1876	do...	200, 371,

Miscellaneous manufacturing.

Each succeeding year the returns show a rapid increase in general manufactur at Minneapolis.

Comparative statement for the last six years.

1881	$14, 872,
1880	10, 333,
1879	8, 155,
1878	5, 696,
1877	4, 802,
1876	3, 776,

Logs.

There were 1,100,000 feet of logs, valued at $9,500, run over the Falls of Saint Anth through the sluice-way, destined for the boom below, during the season of 1881.

It is expected that there will be 5,000,000 feet of logs, valued at $47,000, run o the falls through the sluice-way during the season of 1882. This last spring, in c sequence of a sudden rise in the river above the falls, one of the large booms of the Mississippi and Rum River Boom Company broke and let loose some 5,000,000 feet of logs, which were carried over the falls, *but not through the sluice-way*, as the head of the sluice was obstructed by deposits of earth, &c., made by J. B. Bassett & Company, of Minneapolis.

V 2.

IMPROVEMENT OF MISSISSIPPI RIVER ABOVE THE FALLS OF SAINT ANTHONY, MINNESOTA.

The work has consisted in the removal of bowlders from the channel, construction of wing-dams, and removal of snags and leaning trees and "sweepers" from the channel and bends between Aitken and Grand Rapids, north of the line of the Northern Pacific Railroad.

The work was performed by day-labor and purchase of materials as needed; the crews were subsisted.

The outfit was increased during the season by the construction of one derrick-boat, with crab and capstan, one quarter-boat, bateau, &c.

There were removed during the fiscal year ending June 30, 1882, 194 cubic yards of bowlders, which were utilized in building 195 linear feet of dams; also, removed seventeen hundred and eighty snags and fifteen thousand two hundred and two leaning trees and 274 cubic yards of clay and gravel. Stretch of river worked over about 36 miles.

The improvement thus far has been of great benefit to steamboat navigation as well as to running of logs.

The delays to steamers, formerly lasting for weeks and even months, are now very much reduced.

Mr. Rufus Davenport, who is deserving of credit for his conduct of the work as overseer, was relieved in February by Mr. F. Terry and assigned to charge of dredging operations on the Red River of the North. His report of operations on the Mississippi above the falls is herewith.

Aitken, on the Northern Pacific Railroad, serves as a base of supplies for the extensive lumber camps throughout Northern Minnesota, and the supplies have been forwarded by river in flat-boats as well as by steamers.

There are now two steamers plying the river between Grand Rapids and Aitken. The steamer built last year, above Pokegama Falls, has been purchased by the United States for use in constructing the reservoirs above Grand Rapids.

After the completion of the reservoirs shall have assured sufficient depth of water in the channel down to Minneapolis, a few stretches of rapids below Brainerd excepted, the only annual expense that will probably occur will be that necessary for the occasional removal of snags and leaning timber. An improved channel will doubtless result in the building of additional steamboats above Brainerd, if not above Minneapolis.

The project under which the work of improvement is being carried on is based upon the estimate for the improvement of the stretch of river from Conradis Shoals (35 miles below Brainerd) to Grand Rapids, the original estimate being $54,127.50, as given in the report of February 8, 1875, upon part of the third subdivision, Mississippi transportation route to the seaboard.

The amount expended under this project (Conradis Shoals to Grand Rapids) to June 30, 1882, is $21,640.73.

As to expenditure between Saint Cloud and Minneapolis prior to 1879, please see Annual Report for year ending June 30, 1881.

The present Congress not having appropriated as yet for this piece of river for the year ending June 30, 1883, nothing can be said, here, as to work on it for the coming fiscal year. Even if Congress does appropriate, this year, the amount asked, the sum of $10,000 will be required for the fiscal year ending June 30, 1884.

This work is in the collection district of Minnesota. The nearest port of entry is Duluth, Minn., at which place the revenue collected for the fiscal year ending June 30, 1882, amounted to $13,658.98.

ABSTRACT OF APPROPRIATIONS MADE FOR THE IMPROVEMENT OF THE MISSISSIPPI RIVER ABOVE THE FALLS OF SAINT ANTHONY, MINNESOTA.

By act approved:		
June 23, 1874*		$25,000 00
August 14, 1876		20,000 00
June 14, 1880		15,000 00
March 3, 1881		10,000 00
		70,000 00
Original estimate for the work between the Falls of Saint Anthony and Saint Cloud, Minn		144,667 50
Remaining to be appropriated		124,667 50
Original estimate for the work between Grand Rapids and Conradis Shoals		54,127 50
Appropriations by acts approved—		
June 14, 1880	$15,000 00	
March 3, 1881	10,000 00	
		25,000 00
Remaining to be appropriated		29,127 50

Money statement.

July 1, 1881, amount available		$16,942 04
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$11,820 18	
July 1, 1882, outstanding liabilities	1,762 59	
		13,582 77
July 1, 1882, amount available		3,359 27
Amount appropriated by act passed August 2, 1882		10,000 00
Amount available for fiscal year ending June 30, 1883, viz, improvement between Grand Rapids and Conradis Shoals		13,359 27
Amount (estimated) required for completion of project		19,127 50
Amount that can be profitably expended in fiscal year ending June 30, 1884		10,000 00

REPORT OF MR. RUFUS DAVENPORT, OVERSEER.

ENGINEER OFFICE UNITED STATES ARMY,
Saint Paul, Minn., February 28, 1882.

SIR: I have the honor to submit the following report of work done under my charge on the Mississppi River above Aitken, Minn., from July 1 to the close of navigation, November 12, 1881.

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* Made and expended before the adoption of the present project.

FLEET No. 1.

The removal of overhanging trees and snags was continued by fleet No. 1 up to the 14th of July, when work was commenced on Hale's Rapids. Eight days were occupied in the improvement of that point; 40.7 cubic yards of bowlders were removed, and 55 linear feet of stone dam built with the bowlders taken from the channel. Work was then resumed on trees and snags and continued down river; 2 large bowlders, 1 in section 33, township 54, range 24, and one in section 9, township 53, range 24, containing 35.4 cubic yards, were also taken out.

On the 5th of August the fleet moved to Pine Rapids, and the opening of a 3-foot low water channel continued until the 31st of August; 66.7 cubic yards of bowlders, and 274.4 cubic yards of clay, sand, and gravel were removed, giving a 3-foot channel, as shown on map of Pine Rapids accompanying this report. The bowlders were used in constructing 90 feet of dam; the clay, gravel, &c., were principally carried away by the scour of the water, the material being first loosened by dynamite, and then raked until the desired depth was reached.

On the 1st of September the fleet moved to Crooked Rapids, and work was continued at that point until the 14th. Fifty-one cubic yards of bowlders were taken out, and 50 feet of dam built. The heavy rains in September had, by this time, so raised the river that it became necessary to abandon work on the rapids, and resume the removal of trees and snags, and this work was continued until the 5th of November, when the boats were moved to Aitken for the winter.

SUMMARY OF WORK DONE BY FLEET NO. 1.

From July 1 to November 5, fleet No. 1 removed three hundred and one snags, three thousand nine hundred and thirty-one overhanging trees, 193.9 cubic yards of bowlders, and 274.4 cubic yards of clay, sand, and gravel. One hundred and ninety-five linear feet of dam were built with the bowlders taken from the channel. Length of river cleared, 24 miles. Two hundred and sixty-one charges of dynamite, exploded by an electro-magnetic battery, were used in blasting stone and in dislodging snags.

FLEET No. 2.

As instructed in your letter of July 23, I commenced the construction of a fleet of new boats. The timber and other material commenced to arrive at Aitken early in September, and the boats were completed and launched on the 30th of that month. The new fleet, as constructed, consists of 1 derrick boat, 50 by 20 feet, with crab and capstan; one quarter boat, 70 by 11 feet, with accommodations for 16 men; and 1 bateau, 35 feet long.

COST OF CONSTRUCTION.

Derrick boat	$772 53
Derrick-boat machinery	464 72
Quarter boat	467 77
Quarter-boat equipment	149 34
Bateau	35 00
Total	1,889 36

WORK DONE BY FLEET NO. 2.

On the completion of the boats they were towed to Hamilton's Landing, a point 25 miles below Grand Rapids, and on October 5 commenced the removal of overhanging trees and snags, and continued at that work until the 5th of November, when they were moved to Aitken. Eight hundred and seventy-three snags and one thousand nine hundred and fifty-one trees were taken out. Ten charges of dynamite were used in dislodging snags. Total length of river cleared, 5 miles.

On the 12th of November the boats were dismantled and the equipment stored at Aitken. F. W. Bonness was engaged as watchman and storekeeper at $30 per month. An inventory of all boats and other property left at Aitken is filed in this office.

STATISTICAL.

During the season of 1881 the steamer City of Aitken made nineteen trips, commencing on the 1st of May and ending on the 5th of November, an average of 1 trip in ten days. Total distance traveled, 6,080 miles, carrying, with two barges, 1,100 tons of freight, and one thousand five hundred and forty passengers.

Two new steamboats were built, one at Aitken and the other on the upper river above Pokegama Falls. Owing to bad weather in September, they were not completed in time for the fall work, but will both be ready to commence operations immediately on the opening of navigation in the spring.

The boat above Pokegama Falls, with two barges, will be capable of carrying 100 tons of freight and 50 passengers. The boat on the lower river is to run in connection with the City of Aitken and make weekly trips, carrying mail and passengers, and, with one small barge, can take 40 tons of freight.

DETAILS OF WORK.

Fleet No. 1.

	Overhanging trees.	Diameter in inches.							
		4 to 6.	8 to 10.	12 to 14.	16 to 18.	20 to 22.	24 to 26.	28 to 30.	Totals.
1881.									
July	Hale's Landing to Long Island—12 miles.	853	316	121	34	1	1	....	1,326
August	Hale's Landing to Long Island—12 miles.	86	32	7	2	...	....	....	127
September	Crooked Rapids to Ox Portage—6 miles.	383	226	87	18	...	1	1	716
October	Ox Portage Rapids to 5 miles below.	796	480	208	34	....	1	....	1,519
November	Ox Portage Rapids to 1 mile below.	124	76	37	5	....	....	1	243
		2,242	1,150	460	93	1	3	2	3,931

	Snags.	Diameter in inches.								
		4 to 6.	8 to 10.	12 to 14.	16 to 18.	20 to 22.	24 to 26.	28 to 30.	32 to 34.	Totals.
1881.										
July	Hale's Landing to Long Island—12 miles.	8	25	14	2	....	3	....	....	52
August	Hale's Landing to Long Island—12 miles.	....	9	5	1	....	....	....	....	15
September	Crooked Rapids to Ox Portage—6 miles.	10	22	22	10	1	....	1	....	66
October	Ox Portage Rapids to 5 miles below.	....	61	59	14	3	1	....	....	138
November	Ox Portage Rapids to 1 mile below.	....	15	8	5	1	....	....	1	30
		18	132	108	32	5	4	1	1	301

	Bowlders, clay, and gravel.	Bowlders.	Clay and gravel.
1881.		*Cubic yards.*	*Cubic yards.*
July	Hale's Rapids	40.7	....
July	Section 33, township 54, range 24	15.5	....
August	Section 9, township 53, range 24	19.9	....
August	Pine Rapids	66.7	274.4
September	Crooked Rapids	51.1	....
		193.9	274.4

Fleet No. 2.

	Overhanging trees.	Diameter in inches.						
		4 to 6.	8 to 10.	12 to 14.	16 to 18.	20 to 22.	24 to 26.	Total.
1881.								
October......	Long Island to 5 miles below............	1,089	297	68	16	1	1	1,472
November ...	Long Island to 1 mile below............	304	119	30	19	5	2	479
		1,393	416	98	35	6	3	1,951

	Snags.	Diameter in inches.							
		4 to 6.	8 to 10.	12 to 14.	16 to 18.	20 to 22.	24 to 26.	32 to 36.	Tota
1881.									
October	Long Island to 5 miles below	446	183	99	13	2	1	3	747
November ...	Long Island to 1 mile below	85	20	16	2	1	2	......	126
		531	203	115	15	3	3	3	873

COST OF WORK.

Fleet No. 1, snags, &c..................................	59½ cents per tree or snag.
Fleet No. 1, clay and bowlders..........................	324½ cents per cubic yard.
Fleet No. 1, dams.......................................	83½ cents per cubic yard.
Fleet No. 1, subsistence................................	59⅜ cents per ration.
Fleet No. 2, snags, &c..................................	43½ cents per tree or snag.
Fleet No. 2, subsistence................................	60½ cents per ration.

Boat No. 2 was built especially for handling trees and snags, and is fitted with long boom. Boat No. 1 is better adapted for raising stone, &c.

In connection with the other work, I made the following gaugings of the river: four observations at Grand Rapids, four at Ox Portage Rapids, three at outlet of Sandy Lake, and three at Aitken.

Grand Rapids.

	Cubic feet per second.
1881.	
October 18, 1 observation....................................	2,150.39
2....do..	2,121.99
3....do..	2,063.97
4....do..	2,025.12

Average discharge, 2,090.36 cubic feet per second; stage 4.8 above the low water of 1879; elevation, 1,249.2 above the sea.

Ox Bow Portage Rapids.

	Cubic feet per second.
1881.	
October 22, 1 observation....................................	3,283.04
2....do..	3,428.46
3....do..	3,410.69
4....do..	3,379.82

Average discharge, 3,375.50 cubic feet per second; stage, 5.1 above low water of 1879.

Outlet of Sandy Lake River (below).

	Cubic feet per second.
1881.	
November 7, 1 observation....................................	3,838.38
2....do	4,031,57
3....do	3,974.34

Average discharge, 3,948.09 cubic feet per second; stage, 4.9 above low water of 1879; elevation, 1,214.826 above the sea.

Aitken, Minnesota.

1881.	Cubic feet per second.
November 11, 1 observation	5,598.86
12, 1 ... do	5,401.39
1 ... do	5,529.86

Average discharge, 5,510.04 cubic feet per second; stage, 7.1 above the low water of 1879; elevation, 1,194.9 above the sea.

NEXT SEASON'S WORK.

The accompanying map of the Mississippi River from Grand Rapids to Aitken will show the portions of the river from which obstructions have been removed during the working seasons of 1880 and 1881.

There still remain 90 miles of river to be cleared of overhanging trees and snags, and the improvement of Crooked, Sandy Lake, Moose, and Island Rapids has been but partial. Pine and Hale's Rapids will require no further work; maps of these last, showing condition after improvement in 1881, are submitted. The river above Pokegama Falls will also require some work to render it navigable at low water; the principal obstruction is a small rapid about 6 miles below Little Winnibigoshish Lake. The improvement of this rapid will require (estimate made from survey of 1874) the construction of 750 feet of wing-dams. But the river at this point is full of bowlders, and I think that the removal of these from the channel, and the construction of dams with the bowlders taken out, will give sufficient depth of water, without the river should reach an exceptionally low stage.

After the construction of the dam at Lake Winnibigoshish the ordinary summer discharge will be much more than can by any possibility be required for navigation. If it should be considered advisable to move one of the boats now in use on the lower river above the Falls of Pokegama for this work, I should recommend that advantage be taken of the first high-water in the spring, when the boats can be taken over Grand Rapids without difficulty, and the only portage required will be about 1,000 feet around Pokegama Falls; though I should recommend that both boats now on the lower river be retained there, and would suggest that a barge borrowed from the work at Winnibigoshish, and fitted with a derrick at small expense, could be made to do all the work necessary.

Very respectfully, your obedient servant,

R. DAVENPORT,
Overseer.

Capt. CHARLES J. ALLEN,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Lumber, lath, and shingles manufactured on the Mississippi River above the Falls of Saint Anthony.

	1880.	1881.
	Feet.	*Feet.*
Lumber	241,157,989	339,162,1
Shingles	88,446,125	128,532,05
Lath	49,423,100	70,380,75

Logs.

The logs run during 1881 between Minneapolis and Sauk Rapids amounted to 22,000,000 feet, valued at $1,760,000, and on the river above Aitken they amounted to 216,000,000 feet, valued at $17,280,000.

Since 1878 there has been no use made of the river between Minneapolis and Saint Cloud for any purposes of commerce except the running of logs. In that year but one steamboat plied on the river above the Falls of Saint Anthony between the points named. She made only thirty trips (six to Clearwater, twenty-four to Saint Cloud), carrying upstream merchandise and machinery amounting to 375 tons, and bringing downstream live stock, wheat, potatoes, &c.; also 6 barges hoop-poles, 600 cords wood, and 200,000 feet, board measure, lumber. Passengers carried, about 600.

In the years 1855, 1856, 1857, 1858, and 1859, before the railroad was built, steamboats were run between Minneapolis and Saint Cloud during high-water, as high as four being engaged in the trade at one time. There is no record, however, of the amount of business done.

During the season of 1881 the steamboat plying between Aitken and Grand Rapids made nineteen round trips. She commenced running on the 1st of May and ceased running November 5, an average of one trip in ten days. Total distance traveled, 6,080 miles, carrying, with two barges, 2,200,000 pounds of freight and 1,540 passengers.

There is another steamboat being built at Aitken, and which will probably be ready for business the latter part of July. She will also ply between Aitken and Grand Rapids, and will carry the mail and freight and passengers.

The steamboat built last fall above Pokegama Falls to ply between that point and Lake Winnibigoshish was, this spring, purchased by the Engineer Department, and is now doing service in connection with the building of Lake Winnibigoshish Dam.

V 3.

CONSTRUCTION OF LOCK AND DAM ON MISSISSIPPI RIVER, AT MEEKER'S ISLAND, MINNESOTA.

The present project is given in the Report of the Chief of Engineers for the fiscal year ending June 30, 1874, and based upon the results of a survey made during that year.

The object of the improvement is to connect with the improvement of the Mississippi below Saint Paul, so as to secure steamboat navigation up to the Falls of Saint Anthony.

The improvement of the Mississippi River above the Falls of Saint Anthony, and from Saint Paul to the Gulf of Mexico, has been adopted by Congress, but no appropriations have been made for improving the stream between Saint Paul and the site of the proposed lock and dam at Meeker's Island. The cost of lock and dam, as estimated in the report above referred to, is:

Masonry lock, 300 feet long, 80 feet wide, with lift of 17 feet, about	$630,261 46
Timber dam	291,860 00
Total cost of improvement	922,121 46

Congress, by act approved July 23, 1868, made a grant of 200,000 acres of public lands to the State of Minnesota to aid the State in constructing the lock and dam in accordance with plan and estimate previously submitted.

By act approved March 3, 1873, Congress appropriated—

> For constructions of the lock and dam on the Mississippi River at Meeker's Island, Minnesota, according to the surveys and plans of the War Department, $25,000: *Provided*, That all rights and claims in and to the land grant made to the State of Minnesota for the above work by act approved July 23, 1868, shall be fully relinquished to the United States before any of this appropriation is expended.

No work has as yet been done, the appropriation not being available, as the parties holding the land grant have not made the required relinquishment.

The State of Minnesota should annul the grant to the parties holding the land grant, and release the same to the United States.

No appropriation is asked for the fiscal year ending June 30, 1884.

This work is in the collection district of Minnesota. Duluth, Minn., is the nearest port of entry, at which place the revenue collected for the fiscal year ending June 30, 1882, amounted to $13,658.98.

For commercial statistics, see annual report improving Falls of Saint Anthony and improving Mississippi River above Falls of Saint Anthony.

Money statement.

July 1, 1881, amount available	$25,000 00
July 1, 1882, amount available	25,000 00
Amount (estimated) required for completion of existing project	922,121 46

V 4.

IMPROVEMENT OF CHIPPEWA RIVER, WISCONSIN.

Work principally consisted in building brush and stone jetties, repairs to old work, &c.

Quantity of work done, 1,108.73 cords brush and 6,603.51 cubic yards stone placed, and 40 cubic yards earth excavation.

The work was done by contract entered into with Messrs. Simar & Morton June 4, 1881, and was in every respect satisfactory.

The present project for the improvement of the Chippewa River is stated in my annual report for year ending June 30, 1881. The cost of the project was based upon a survey made about 1875, and upon the prices of material and labor that then existed.

A new survey of the river ought to be made to ascertain the cost of completion of the work. Such survey would cost about $6,000.

The result of the work to date has been in the highest degree beneficial to the navigation interests of the stream. Lumber rafts are no longer detained by bars at the confluence of the Chippewa and Mississippi, a fact fully appreciated by those accustomed to detention before the work of improvement commenced.

I append, hereto, a copy of my letter of May 22, 1882, to the Chief of Engineers, regarding the useless obstruction of the Chippewa River by bridges, and would add that unless Congress provides laws to protect works of river improvement ordered by Congress, the works and the constituents suffer.

Mr. G. O. Foss was inspector on the part of the United States during the season of 1881, and Mr. F. T. Hampton, assistant engineer, had local charge for the rest of the year. To this latter gentlemen I am much indebted for skillful and energetic management of the work.

The present Congress not having as yet made any appropriation for this stream, I cannot refer to any appropriation this year. If the amount asked for the fiscal year ending June 30, 1883, be granted by the present Congress, the sum of $2,790 can be profitably expended during the fiscal year ending June 30, 1884. It is hoped, however, that an appropriation for a full survey will be granted by the next Congress.

This work is in the collection district of Minnesota. Duluth, Minn., is the nearest port of entry, at which place the revenues collected for the fiscal year ending June 30, 1882, were $13,658.98.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING CHIPPEWA RIVER, WISCONSIN.

By acts approved—	
August 14, 1876	$10,000 00
June 18, 1878	10,000 00
March 3, 1879	8,000 00
June 14, 1880	10,000 00
March 3, 1881	10,000 00
Total	48,000 00
Original estimate for carrying out existing project	139,892 50
Remaining to be appropriated	91,892 50

Of this amount ($139,892.50) $64,102.50 was estimated as the cost of protecting the high sand-banks below Eau Claire.

Money statement.

July 1, 1881, amount available		$16,118 93
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$12,398 07	
July 1, 1882, outstanding liabilities	3,215 63	
		15,613 70
July 1, 1882, amount available		505 23
Amount appropriated by act passed August 2, 1882		35,000 00
Amount available for fiscal year ending June 30, 1883		35,505 23
Amount (estimated) required for completion of existing project		56,892 50
Amount that can be profitably expended in fiscal year ending June 30, 1884:		
For improvement	$2,790 00	
For survey of the river	6,000 00	
		8,800 00

COMMERCIAL STATISTICS, CHIPPEWA RIVER, 1881.

342,878,000 feet lumber, at $12 per M	$4,114,536 00
121,437,000 shingles, at $2.50 per M	303,592 75
64,787,600 lath, at $2 per M	129,575 25
1,880,900 pickets, at $10 per M	18,809 00
15,000 railroad ties, at 40 cents each	6,000 00
300,000,000 feet logs, Beef Slough, at $9 per M	2,700,000 00
	7,272,513 00

Steamboats commenced running April 21 and ceased running November 16. Two steamboats plied between Read's Landing and Eau Claire; one steamboat plied between Read's Landing and Dunnville.

Number of tons of freight carried	1,966
Number of passengers and raftmen carried	16,989
Amount received for carrying freight and passengers	$39,502 50

Under date of December 7, 1880, Ingram, Kennedy & Co., of Eau Claire, Wis., extensive dealers in lumber, lath, and shingles, say:

"Had it not been for the work done by the government at the mouth of the Chippewa, we could not have run our rafts or boats during the low water of the past season."

LETTER OF CAPT. C. J. ALLEN, CORPS OF ENGINEERS, RESPECTING THE CONSTRUCTION OF BRIDGES ACROSS CHIPPEWA RIVER, WISCONSIN.

ENGINEER OFFICE, U. S. ARMY,
Saint Paul, Minn., May 22, 1882.

GENERAL: I have the honor to make the following report upon certain railroad bridges recently built and partly built across the Chippewa River, in Wisconsin.

Noticing in the newspapers about the early part of March some allusions to the bridges, I communicated with the chief engineer of the Chicago, Milwaukee and Saint Paul Railway Company, who referred, or stated the contents of, my letter to Mr. J. C. Easton, the president of the Chippewa Valley and Superior Railway Company, the company owning the bridges. Mr. Easton directed his chief engineer to furnish me with such information as I desired. The sketches furnished me were so meager in detail that I directed Assistant Wells to proceed to Eau Claire and obtain what was needed. The chief engineer of the railroad finally sent me an additional set of maps, but they are not full as to detail.

The bridges in question are:

1. The North Eau Claire.
2. The West Eau Claire or Shawtown Bridge.
3. The Dunnville Bridge.

All are railroad bridges.

As to the first or North Eau Claire Bridge, having heard no complaint about it, and there being little possibility of it ever standing in the way of navigation, it is not included in this discussion.

The Shawtown Bridge, as may be seen by the tracings herewith, has its piers oblique to the direction of the current, and draw-spans affording a width in the clear of but 51 feet. The other spans, intended for the passage of rafts, are apparently wide enough, but it is more than probable that sheer-booms will be found necessary for their safe passage. Aside from the extreme narrowness of the draw-span, the obliquity of the current to the axis of the draw-pier, both above and below the bridge, and the close proximity of the enormous sand-bar just below, render the passage of this draw unsafe.

I had an interview with the chief engineer, Mr. Sill, on the 13th of the month, at Eau Claire, in regard to these bridges. He stated that he was about to place a sheer-boom on the left bank of the river, above the Shawtown Bridge, its lower end to rest against the upstream starling of the draw-pier, so as to guide descending steamers into the right draw-span. This boom will close the left draw-span (clearance).

About two or three weeks ago, a steamer, in attempting to get through the draw, was carried by the current against the draw-pier and remained, as I am informed, directly across the pier for several hours before it could be extricated.

This bridge was commenced in October, 1881, and finished in March, 1882.

The Dunnville Bridge is situated above the mouth of the Menomonee or Red Cedar River, at a point about 20 miles below Eau Claire. As may be seen by the tracings herewith, it crosses the river at a pronounced bend; it provides for raft and draw spans of about the same width as does the Shawtown Bridge. This bridge was commenced in February last, and is not completed. The draw-pier is not yet built, and its truss consequently not in place. Upon my return from Eau Claire, I received a letter from Capt. E. E. Heerman, the proprietor of several steamers, plying the Chippewa River, setting forth the obstruction caused by this bridge. I immediately proceeded, in company with Captains Heerman, Sheckle, Mahlon, and Minder, to examine the ground.

Aside from the deficient widths of draw-spans, the bridge is badly located with reference to navigation. It crosses at a sharp bend, and the directions of currents, at the time of my examination (May 17), evidently made angles with the axes of the piers of from 20° to 30° and upwards, counting from the left to the right bank of the river. The water, at the time of my examination, was high, and the river full of logs, many of which had lodged in masses against the upstream faces of the piers, thus diminishing the clearance of spans. Doubtless, as the water lowers and if logs are prevented from lodging against the piers, the angles made by the currents with the axes of the piers will diminish. But, in time of low water, the main channel will be close to the left bank, where there is now a raft-span built, and the draw, which should have been close to the left bank (and of sufficient width), will, in addition to insufficient width of spans, have insufficient depths of water. The whole situation is bad, and not easily rectified. A better, though not entirely unobjectionable crossing, could have been obtained some 800 to 1,200 feet below the present one, which seems to have been fixed upon with a view of economy in building the railroad approaches.

The engineer of the road informed me that the steamboat men had all been consulted before the bridges were decided upon and that they had interposed no objections. Such of the latter as I met at Dunnville informed me that they had supposed the width of draw as shown them to be a clear width; in other words, they did not know that a draw-pier was to intervene and reduce the width of passage to about 51 feet, especially so at Dunnville.

As to the Chippewa River, a bridge might be commenced and finished without this office being aware of it, unless some one interested afforded information. The appropriations for its improvement have been so small, that, upon the completion of work of any one season, the inspector has been discharged, and no one therefore remained upon the ground to notice events.

The necessity of a general law by Congress regarding the bridging of navigable waters of the United States, especially those for whose improvement Congress has made appropriations, is exemplified in this case. There being no act of Congress, that I know of, applicable to these bridges, it would seem that the interests affected must seek redress in the usual manner. I have thought, however, that the matter should be reported to the department.

The steamers that will have to pass the draws vary in width; the widest, at present, is the Minnie Heerman, which has 30 feet 4 inches breadth of beam. The width of barges runs as high as 16 feet 8 inches. It is evident, then, that a steamer with one barge should require a width of much more than 51 feet for safe passage, and that, in the case of a steamer with two barges, the passage of a draw but 51 feet in width would be an impossibility.

The following are inclosed herewith:

Copy of letter from Capt. E. E. Heerman, dated May 6, 1882.
Tracing showing plan of Shawtown Bridge.
Tracing showing plan of Dunnville Bridge.
(These tracings are drawn to a scale of 1 inch to 100 feet.)
Tracing showing plan and elevation of Shawtown Bridge, and of the Dunnville Bridge, drawn to a scale of 1 inch to 100 feet.

The originals of the tracings were furnished by Mr. Sill, the chief engineer.

Very respectfully, your obedient servant,

CHARLES J. ALLEN,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

V 5.

IMPROVEMENT OF SAINT CROIX RIVER, MINNESOTA AND WISCONSIN.

The work for the improvement of this stream has consisted in the removal of obstructions from the channel, as snags, stumps, old cribs, leaning trees, and the contraction of channels by means of wing dams, jetties, and closing of secondary channels. The work was done by day labor, and purchase of materials in open market, and was continued throughout the greater part of the winter, the working party moving on the ice. There were removed during the year one hundred and seventy-three stumps, snags, and leaning trees. There were, also, 3,314 cubic yards of rock quarried and gravel excavated and placed in dams, revetment, &c.; 2,896 cords of brush cut and placed in dams, revetment, &c., and about 3,300 linear feet of dams and revetment placed, repaired, and leveled up. There were also about 997 linear feet of old revetment repaired.

Temporary relief to navigation was afforded by scraping bars with railroad scrapers worked by horses through block and tackle on shore.

The trade and commerce of the valley have been greatly benefited by the work done to date, and detention of steamers and barges has been almost unknown since the work of improvement by the United States was fairly started. The Boom Company, whose grounds obstruct the river a number of miles above Stillwater, have of late years met the Engineers in a spirit of fairness that went far towards abolishing the difficulties to navigation in this part of the river that existed for so many years prior to the commencement of the work of improvement by the United States.

It is understood, however, that the management of the Boom Company has very lately changed into other hands; it is to be hoped, for the interest of the entire valley, that the policy of the company will not change.

It is understood, however, at the date of this writing, that the bill introduced into Congress last winter to extend the provisions of section 5254, title LXIII, Revised Statutes of the United States, second edition, 1878, so as to include the Saint Croix River, passed. This section provides practically for the regulation, by the Secretary of War, of the placing of cribs or piers for boom purposes in a manner not to interfere with navigation.

The past winter was an unusual one; the river began to break up early in February, causing enormous masses of ice to gorge and ground at a number of points, and especially at the foot of the Dalles; the confined water, making its escape by the lines of least resistance, scoured the bed of the stream, and in some cases effected injurious changes, particularly so above Clark's Slough.

The present project for improvement, viz, the removal of obstructions from the bed of the stream, construction of dams and revetment of banks, is based upon the report of the survey of 1879 and printed as Appendix U, Report of the Chief of Engineers for year ending June 30, 1880. The estimate was $60,250 for the improvement from Taylor's Falls, Minnesota, to Prescott, Wis., and was made to supersede that of 1874, which latter, having been based upon a survey made at high water, was altogether too low. It is believed that all the estimates for the improvement of this river (a stream with movable bottom and banks) have been too low, although made with much care. The enormous advance in price of labor and cost of material during the past year has its effect in reducing the amount of work that can be done with a certain amount of money. This is more fully explained in letter of Captain Allen, February 25 last, to the Chief of Engineers, a copy of which accompanies this report. In that letter it is proposed to add to the estimate of January 26, 1880 (said estimate based upon report of the survey of 1879), the sum of $23,200, thus bringing the estimate up to $83,450. If this change in estimate be allowable, the amount necessary to complete the project under that estimate will be $65,450.

Congress not having as yet made the appropriation for this stream asked for the fiscal year ending June 30, 1883, nothing can here be said as to proposed work for the coming season; and if this amount asked for for year ending June 30, 1883, be appropriated by the present Congress, the sum of $35,450 can be profitably expended upon the stream from Taylor's Falls to Prescott for the year ending June 30, 1884.

Capt. O. F. Knapp, overseer in local charge of the work, has carried out his instructions faithfully and economically.

The Saint Croix River is in the collection district of Minnesota. The nearest port of entry is that of Duluth, Minn., at which place the revenue collected during the fiscal year ending June 30, 1882, amounted to $13,658.98.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING SAINT CROIX RIVER, MINNESOTA AND WISCONSIN.

By acts approved—	
June 18, 1878*	$10,000
March 3, 1879*	8,000
June 14, 1880†	10,000
March 3, 1881	8,000
Total	36,000

Amount (estimated) required for completion of existing project ($83,450), $65,450.

Money statement.

July 1, 1881, amount available		$9,715 72
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$9,648 83	
July 1, 1882, outstanding liabilities	43 32	
		9,692 15
July 1, 1882, amount available		23 57
Amount appropriated by act passed August 2, 1882		30,000 00
Amount available for fiscal year ending June 30, 1883		32,023 57
Amount (estimated) required for completion of existing project		35,450 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		35,450 00

COMMERCIAL STATISTICS, SAINT CROIX RIVER, 1881.

FREIGHT AND PASSENGERS.

There were but two steamboats engaged exclusively in the freight and passenger business during the season of 1881. They commenced running about April 15, and ceased running about November 15.

There were eighty-one round trips made between Hastings and Stillwater, and one hundred and seventy-eight round trips between Stillwater and Taylor's Falls.

The number of passengers carried during the season amounted to 11,015.

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*Appropriated before adoption of original project, and the project based upon the report of the survey of 1879 (see report of Capt. Charles J. Allen, January 26, 1880, printed as House Ex. Doc. No. 40, Forty-sixth Congress, second session), and before the adoption of the existing project, viz, $83,450.

Two thousand dollars of the appropriation of 1879 was used in making survey of the river from Taylor's Falls to Prescott during 1879.

†About $300 of this amount was expended in the improvement of the slough on the east side of the river, known as the canal, between Four Mile Island and the foot of Saint Croix Boom.

Freight business.

Commodities.	Number of pounds carried up-stream.	Number of pounds carried down-stream.	Total number of pounds carried.
Flour	191,000	21,400	212,400
Wheat	1,594,250	8,692,490	10,286,740
Merchandise, &c	2,820,882	472,366	3,293,248
Lime	605,700	226,000	831,700
Bran and feed	743,642	56,000	799,642
Salt	786,700	37,000	823,700
Potatoes	....	461,040	461,040
Lumber	2,229,332	14,816,000	17,115,332
Total	9,041,506	24,782,296	33,823,802

Live stock carried up and down, number, 1,013.

LUMBER, LOGS, RAFTING, AND TOWING, SEASON OF 1881.

		Manufactured.	Value.
Lumber	feet	135,333,660	$2,300,000
Shingles	pieces	70,938,500	141,877
Lath	number	40,236,750	80,473
Pickets	do	362,000	43,440

Logs.—About 233,000,000 feet of logs passed through the Saint Croix Boom during the season of 1881, which, at an estimated value of $11 per thousand feet, would represent the sum of $2,563,000.

The amount of logs handled during the season was 27,000,000 feet in excess of last previous season.

Rafting.—The amount of lumber and logs rafted foots up about 185,000,000 feet.

Towing.—There were thirty-five to forty steamboats engaged in the towing of lumber and logs to various points during the season.

It is said that the business of lumber, logs, rafting, and towing for 1882 will be as large, if not larger, than that of 1881.

Opening and closing of navigation on the Saint Croix River.

Year.	Opened.	Closed.
1863	April 7	November 30
1864	April 5	November 12
1865	April 18	November 24
1866	April 10	November 25
1867	April 10	November 24
1868	March 26	November 25
1869	April 9	November 13
1870	April 5	November 21
1871	March 29	November 22
1872	April 8	November 20
1873	April 5	November 25
1874	April 15	November 13
1875	April 12	November 15
1876	April 18	November 25
1877	April 8	December 31
1878	April 2	November 20
1879	April 4	November 17
1880	April 1	November 13
1881	April 12	November 14
1882	April 3	

LETTER OF CAPT. CHARLES J. ALLEN, CORPS OF ENGINEERS.

ENGINEER OFFICE, UNITED STATES ARMY,
Saint Paul, Minn., February 25, 1882.

GENERAL: I have the honor to acknowledge the receipt of letter of the Hon. T. C. Pound, dated February 17, 1882, to the honorable Secretary of

War in regard to further information upon the Saint Croix River, referred to me for report by indorsement of the Chief of Engineers, February 21, instant.

A survey of the Saint Croix River was made in 1874 by my predecessor in charge, from the results of which survey the estimated cost of improving the stream from Saint Croix Falls to the mouth was placed at $21,758, the improvement to consist in the removal of old cribs, snags, &c., from the channel, and construction of wing-dams and dams to close secondary channels. The stage of water when this survey was made was too high to admit of the worst obstructions to low-water navigation being seen; hence the estimate for improvement was much too low.

The first appropriation for the improvement of this river was made by act of Congress approved June 18, 1878; the sum appropriated was $10,000.

In 1879, an allotment from the appropriation for that year was made for the purpose of a thorough survey between Taylor's Falls and Prescott. An estimate, based upon this survey, was rendered, in which the cost of completing the improvement was placed at $60,250, to be expended in removal of snags, rock, bowlders, and leaning trees, and similar obstructions throughout the channel, construction of wing-dams, dams to close secondary channels, protection of caving bends, and dredging the bars below Stillwater.

The appropriation of $10,000 following this estimate made by act of Congress, approved June 14, 1880, provided that the sum of "three hundred dollars or so much thereof as in the opinion of the engineers in charge may be necessary, shall be expended in the improvement of the slough on the east side of said river, known as the canal between Four Mile Island and the foot of the Saint Croix Boom."

This canal was opened by private parties connected with the log booms a number of years ago, and before any government work was undertaken on the Saint Croix. Its purpose was to flank the Boom Grounds which. commencing just above Stillwater, almost completely blocked up about 8 miles of the stream for a portion of each season. There was a period, it is understood, before any government work was undertaken, when it was not unusual for steamers and tows to be completely barred out for weeks at a time from the river above the Boom Grounds. Since the work of improvement has been undertaken by the government, owing to arrangements made by the Boom Company, no such protracted delays have occurred; still, there are times when it is absolutely necessary for logs to be run and boomed in such large numbers that steamers experience the utmost difficulty in ascending the river. The logging interest of the Saint Croix Valley is so great and of such importance to the people, that running of logs ought to be recognized, provided the steamboat and barge navigation be not thereby damaged. The establishment of boom piers, &c., and running of logs ought, however, to be regulated by act of Congress.

In the estimate last rendered, viz, $60,250, the improvement of the 8 miles of river covered by the booms was not considered to any great extent, nor the improvement of the canal. The state of affairs did not then seem to justify any decided recommendation as to expenditure.

Examinations were made this winter at various points of the stream, and especially at the canal and at Willow River, and Catfish Bars, and of the river between Osceola and Taylor's Falls.

Just below the latter point and above Clark's Slough through which is the present steamboat channel, secured at considerable expenditure of money, the ice has gorged in immense masses, and rests upon the bottom. The warm weather during the latter part of January and early in February caused an unusual winter flow over the Rapids (Falls), but was not sufficient to impair the solidity of the masses of ice, which assumed such positions as to act like wing-dams deflecting the current from the slough, with a possibility of making the deflection permanent unless remedy can be applied immediately after navigation opens.

The cost of securing an adequate channel through the "canal" and its immediate approaches, now regarded as an essential part of the improvement of the Saint Croix, will not fall short of $15,000.

Dredging and otherwise improving the bars below Stillwater should not be longer delayed, nor should the improvements above Stillwater, now so well under way, and which have thus far proved of such benefit to navigation, fail to serve their purpose through paucity of funds for furthering and perfecting them.

The Saint Croix is, like all rivers flowing through sandy and gravelly beds, difficult of estimating upon for improvement. The channel changes, particularly after floods. The logs, boomed at different points of the stream, act as wing dams, spurs, &c., for the time being, and effect channel changes, generally temporary, sometimes permanent, that the engineer cannot foresee. The practice of the loggers in constructing dams at points on the headwaters of the river and its tributaries for the purpose of collecting water sufficient to suddenly liberate, in order to secure a driving stage for logs that have stranded below the dams, and in operating these dams without system or hinderance is a potent cause of changes in channels, bed, and banks. A single dam on the Snake River, a tributary of the Saint Croix, frequently by its operations affects the oscillation of the water surface below the Falls as much as 2 feet for a number of days at a time. Were these dams constructed and operated in a systematic manner under act of Congress, as would be contemplated in the case of a system of reservoirs, their effect would be to aid rather than impede navigation.

Guided by experience gained since the report of January 26, 1880, was rendered, I should add considerably to the estimate therein given, especially to the cost of dredging. It would not be advisable to build a dredge-boat for the express purpose of improving the bars below Stillwater; and the dredge-boat necessary would have to come, probably, from some point on the lower river, whether the dredging were done by contract or by day labor. Instead of the $16,800 estimated as necessary below Stillwater for improving the bars, I would substitute the item of $25,000.

The addition to the estimate of 1880 would then be, the canal and its immediate approaches included, $23,200.

The sum of $50,000 can be well and profitably expended between Taylor's Falls and the mouth of the river for the fiscal year ending June 30, 1883, of which amount $20,000 to be expended below Stillwater, leaving $30,000 for general improvement of the river between Prescott and the Falls.

Should the coming season be one of unusually low water, prompt and vigorous action at several of the shoal crossings will become necessary in order that traffic, increasing in importance, may not be delayed.

Were the appropriations for the Saint Croix and Chippewa River improvements adequate in amount, and regular, the purchase of a light-draught steamer by the United States Government for use upon both streams in towing barges of brush, stone, &c., and to aid in snagging and pile-driving operations, would be a measure of economy and facilitate the work generally. A suitable steamer would cost about $13,000.

For statistics of the Saint Croix I would respectfully refer to my last annual report.

The letter of Mr. Pound is herewith respectfully returned.

Very respectfully, your obedient servant,

CHARLES J. ALLEN,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

V 6.

IMPROVEMENT OF MINNESOTA RIVER, MINNESOTA.

No work done during the fiscal year for want of funds.

The project for the improvement of the river from its mouth to South Bend (see page 364, Part I, Annual Report of the Chief of Engineers for 1875) contemplated the construction of five locks and dams, and removal of snags, &c., at an estimated cost of $733,868.63. The last appropriation for this stream was made by river and harbor act approved June 18, 1878, and consisted of $10,000.

There has been expended, since the commencement of work upon that stream, the sum of $117,458.

The stream has no commerce worth reporting. No appropriation is asked for the fiscal year ending June 30, 1884.

This work is in the collection district of Minnesota. The nearest port of entry is Duluth, Minn., at which place the revenue collected during the fiscal year ending June 30, 1882, amounted to $13,658.98.

There are no commercial statistics to report. The commerce of the river, even before the advent of the railroad through the Minnesota Valley, was not large in any one season, and since that time only an occasional small " wild " packet has ascended the river.

In May, 1876, two steamboats that went up the river during high-water had to discharge their return freight at Mankato before they could return to the Mississippi River, owing to the great number of snags and other obstructions. With the appropriations by Congress August 14, 1876, and June 18, 1878, however, a large number of these obstructions were removed, though perhaps not in sufficient numbers to make the river an easy one to navigate during periods of low-water.

ABSTRACT OF APPROPRIATIONS MADE FOR THE IMPROVEMENT OF THE MINNESOTA RIVER.

By act approved March 2, 1867	$37,500
By act approved July 11, 1870	10,000
By act approved March 3, 1871	10,000
By act approved June 10, 1872	10,000
By act approved March 3, 1873	10,000
By act approved June 23, 1874*	10,000
By act approved March 3, 1875	10,000
By act approved August 14, 1876	10,000
By act approved June 18, 1878	10,000
Total	117,500

Amount (estimated) required for completion of existing project (see page 364, Part I, Annual Report of Chief of Engineers for 1875), $733,868.63.

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* Used in making survey of river.

Money statement.

July 1, 1881, amount available		$50 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$8 00	
July 1, 1882, outstanding liabilities	9 00	
		17 00
July 1, 1882, amount available		33 00
Amount (estimated) required for completion of existing project		733,833 63

V 7.

IMPROVEMENT OF RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA.

The work done during the year consisted mainly in dredging the bars below Moorhead so as to afford a depth of 3 feet in the channel with 60 to 80 feet width of cut across the bars, at the lowest water. The dredge at the beginning of the fiscal year was at a point 5 miles above the mouth of the Elm River; at the close of the season of 1881 it had reached a point distant 65 miles by river from Moorhead and Fargo.

During the season of 1881 a new dredging machine of somewhat greater capacity and size than the old dredge was completed and launched at Grand Forks. The machinery was furnished by R. R. Osgood, of Troy, N. Y., and the hull built and machine set up at Grand Forks. The new dredge is what is known as the boom-dredge, the same in style as the old one; the hull is 75 by 24 feet; greatest draught, 26 inches; boiler of locomotive pattern with 450 feet of heating surface; double engines, cylinders 8 inches bore by 16 inches stroke; dipper capacity, 1¼ cubic yards.

Experience proving that, as the dredge proceeded down stream, the slide-scow did not, of itself, answer all the purposes of depositing the spoil as desired, a steam derrick or tender was built to be used in carrying the material from the dipper of the dredge by swinging the load of spoil through a second arc; the tender is used sometimes alone with the dredge, at other times in connection with the slide-scow; fitted with grapples, it raises bowlders and snags. The hull of the derrick is 60.5 by 24 feet, and was built and the machinery set up in it by the United States. The machinery was purchased of the Vulcan Iron Works Company of Chicago, and consists of a complete set of dredge machinery, backing drum excepted. The boiler of locomotive pattern, 42 inches in diameter, and 10 feet in length, with 250 square feet of heating surface. It has a single cylinder 13 by 13 inches, with fly-wheel of 5½ feet diameter. The spud-hoisting apparatus consists of two cylinders, one for each spud, 5 feet stroke each, and raised by direct pressure of steam from the boiler. This machine was finished during the latter part of the season of 1881, and together with most of the flats, &c., necessary to the complement of the fleet, quarter-boat, and additional slide-scow, was about ready for work by the latter part of the fiscal year just closed. A small steam-launch, or tug, to be 65 feet in length by 11 feet beam, was commenced in April and nearly finished by the close of the year; and a slide-scow, additional quarter-boat, flat, &c.

Dredging was resumed by dredge No. 1 about the 2d of May, 1882, at the point where it left off in the season of 1881. The derrick-tender accompanied it. The new dredge, after being tested, was moved down the stream from Grand Forks in order to commence work upon the Turtle River Bars.

Quantity of material removed during the fiscal year ending June 30, 1882, by dredge No. 1, 49,292 cubic yards.

Quantity of material removed during the month of June 1882, by dredge No. 2, 3,925 cubic yards.

Total quantity of material removed by dredging since construction of the first dredge by the United States, 166,019 cubic yards.

The material, a tough, leathery clay, with some sand and bowlders. Some few snags and leaning trees were also removed.

The original (which is, with slight modification, the existing) project for the improvement of the river from Breckenridge to the United States and Manitoba boundary line, as given in the Annual Report for the fiscal year ending June 30, 1881, is estimated to cost $145,310.18. Like many of the estimates of the cost of work rendered six or eight years ago, this estimate is too low, and the matter of cost should be, before long, revised.

During the last half year the cost of building materials, labor, food, &c., has advanced 30 and even in many places 50 per cent., and, as a matter of course, the cost and quantity of work are affected correspondingly.

Some 40,000 cubic yards of material in the channel, just above Fargo, need removal by dredging. This item has assumed importance within the past year; in fact, the improvement of the river from Fargo to Breckenridge is now of almost as much importance to the Red River Valley as is the improvement from Moorhead and Fargo to Pembina and Saint Vincent.

The improvements have, thus far, secured a fair high water channel from Fort Abercrombie to Fargo (75 miles in distance), and a good channel for 70 miles below Fargo and Moorhead, affording 3 feet depth at lowest water, or between 5 and 6 feet depth at ordinary low water, the cuts through the bars ranging from 60 feet to 80 feet in width.

It is stated by those in position to know that the transportation of grain and the general commerce of the river are thirtyfold what they were before the work of dredging, by the United States Government, began in 1879.

The spring just past (1882) was a remarkable one for floods in this valley. A copy of report of Assistant Engineer R. Davenport, herewith, gives its main features.

Assistant Wanzer, in his report of operations on the Red River, dated June 30, 1881, reports:

> In conclusion, I would respectfully refer to the exceeding high water of this spring on this river as a subject naturally leading to the question of the examination of the sources of the stream, in reference to the feasibility of constructing reservoirs similar to those proposed on the Upper Mississippi River.
>
> The river above Fergus Falls could at least be examined at a small expense, and undoubtedly advantageous sites could be selected for impounding the surplus spring supplies.
>
> The Red River of the North is so narrow over its entire length, with well defined banks, that an increment of 1,000 cubic feet per second to the ordinary low water discharge would furnish a good navigable stage at all times from Fort Abercrombie to the head of Goose Rapids, while an increment of 2,000 cubic feet per second would, with the aid of some removal of rocks and bowlders, render navigation over Goose Rapids perfectly safe.
>
> Conjecture in the absence of positive knowledge of the country, is futile, but I believe a wise economy would indicate that such an examination as proposed should be made.

I concur with Mr. Wanzer in opinion that an examination of the sources of the Red River, the Otter Tail included, to ascertain what can be accomplished in the way of reservoirs for improving the low-water navigation of the river, ought to be made. Such a survey, with the proper hydrological observations would cost about $8,000; no less should be appropriated if a good survey be required. The idea has many advocates in that region.

The work was in charge of Mr. Charles Wanzer, assistant engineer, until after the close of operations in 1881, when it shortly afterwards was assigned to Mr. Rufus Davenport, assistant engineer, Mr. Wanzer being assigned to construction of reservoirs. Both of these gentlemen deserve credit for their energetic and careful work.

Mr. Wanzer's report of operations from June 30, 1881, to close of season of 1881, also herewith.

No appropriation having been made, as yet, by the present Congress, nothing can be said as to proposed work under any new appropriation.

The sum of $17,310 18 should be appropriated for the fiscal year ending June 30, 1884, plus as much more as an examination recommended to be made this season may show to be necessary. For reasons just stated, bearing upon estimates rendered six or eight years ago, increase of prices of from 30 per cent. to 50 per cent. over what they then were, a revision of the estimates becomes necessary.

The Red River of the North is within the customs district of Minnesota, with Pembina the port of entry.

The amount of duties collected at Pembina and Saint Vincent during the fiscal year ending June 30. 1882, was $27,236.91. The total of all other collections, $8.432.08.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA.

By act approved—

August 14, 1876	$10,00
June 18, 1878	30,00
March 3, 1879	25,00
June 14. 1880	20,00
March 3, 1881	18,00
	103,00
Original estimate for completing existing project, not including lock and dam, at Goose Rapids	$145,310 1
Remaining to be appropriated	42,310 1

Money statement.

July 1, 1881, amount available		$54,299
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$36,551 07	
July 1, 1882, outstanding liabilities	5,611 20	
		42,162
July 1, 1882, amount available		12,137
Amount appropriated by act passed August 2, 1882		10,000 0
Amount available for fiscal year ending June 30, 1883		22,137
Amount (estimated) required for completion of existing project		32,310 1
Amount that can be profitably expended in fiscal year ending June 30, 1884		17,310 1

REPORT OF MR. CHARLES WANZER, ASSISTANT ENGINEER.

ENGINEER OFFICE, UNITED STATES ARMY,
Saint Paul, Minn., June 30, 1882.

SIR: I respectfully submit the report of operations, conducted under your instructions, on the Red River of the North, from June 30, 1881, to the close of that season.

The work consisted of continuance of dredging, the building of a steam scow-derrick at Moorhead, Minn., and the building of a new dredge-boat and barge at Grand Forks, Dak.

FIRST—DREDGING.

This work was continued on from the point reached at the end of the last fiscal year (viz, 5 miles above the mouth of the Elm River) to a distance of about 65 miles, by river, below Moorhead or Fargo.

During the season the dredge worked very satisfactorily, and with fewer delays from breakdowns than ever before. The distance accomplished on its way downstream was not so great as heretofore has been gone over, on account of the greater width of the river and consequent greater expense and delay in removing material from the channel and depositing it near the shore. As an aid in this work, a steam scow-derrick was built, which will enable the dredge to excavate and deposit the material in a large hopper or box, which the derrick will immediately lift, swing and dump on the bank or where desired.

The dredge was worked eleven hours a day during the season, and excavated from June 30, 1881 to end of the season (October 29, 1881) 36,397 cubic yards.

The dredging was done in accordance with the general plan already described in former reports, viz, to furnish a 3-foot low-water channel, and a width of 80 feet.

At the end of the season the entire dredging outfit was towed back to Moorhead; the machinery was taken apart and the dredge-boat hauled out of the river onto the shore for the winter. This was necessary on account of repairs required to the hull, which, being built of green timber, had so shrunken as to require recaulking.

The total cost per cubic yard of the dredging, including repairs, superintendence, and the pulling out of the boat and laying it up for the winter, was 16 cents per yard.

A competent and faithful man was left in charge of the government property for the winter.

SECOND—SCOW DERRICK.

This is a steam derrick located on a barge and intended to be used in carrying material from the dipper of the dredge, and depositing it near the banks of the stream. This, in many cases, and in fact, in nearly every case now that the dredge is working in wider river, obviates the necessity of the dredge having to deposit the excavated material over a slide on a barge, and then backing up and handling it again in order to remove it far enough from the channel for it not to be an obstruction in itself.

The hull of the derrick is of oak frame, planked with pine. It is 60.5 feet in length by 24 feet in width. Work was commenced on the hull about September 1, 1881, at Moorhead, Minn., and the boat was completed, with machinery in good working order, in early November last.

The machinery was purchased of the Vulcan Iron Works Company of Chicago, and consisted of a complete dredge machine, excepting a backing drum. It has hoisting and swinging drums, with oak frame and derrick. The boiler is of locomotive pattern, 42 inches diameter and 10 feet long, having 58 2-inch tubes, and furnishing 250 square feet for heating surface.

It has a single cylinder engine, 13 by 13 inches, with fly-wheel of 5½ feet in diameter. The apparatus for hoisting the spuds is a very simple contrivance, consisting of two cylinders (one for each spud) of 5 feet stroke each, with ports in the upper end, which open and allow the steam to escape as soon as the piston has raised to a height of 5 feet. The raising or thrust of the piston corresponds to the lift of the spud. The piston is raised by steam supplied from the boiler, and is attached by a clamp-bar to the spud. No chains or gearing are necessary, and the entire raising and lowering of the spuds is attended to by the engineer at the boiler. There is no wear and tear excepting the small item of wear on the cylinders. This method of raising the spuds is cheap, durable, and speedy. The total cost of the scow-derrick complete is about $5,400.

THIRD—THE NEW DREDGE.

This was built at Grand Forks, Dak., and was commenced about September 1, 1881. The machinery was built by Ralph R. Osgood, of Troy, N. Y., and the building of the hull and the placing of the machinery was done by the United States. The style of the machinery is the same as the one purchased for dredge No. 1, which has proved so satisfactory. It is larger and stronger, and some improvements are made by the builder in respect to the placing of the machinery.

The frame of the hull and the front and stern planking, the boom and dipper handle, are built entirely of white oak. The bottom and side planking and A braces are of white pine. The dimensions of the hull are 75 by 24 feet. Draught when loaded with wood is 26 inches. The boiler is of locomotive pattern, and furnishes 450 feet of heating surface. It has double-cylinder engines, size being 16 inches stroke by 8 inches bore. The capacity of dipper is 1¼ cubic yards. The total cost of the new dredge is $12,600, and was finished late in the fall—too late to allow of any trial to be made further than the mere running of the machinery for a short time to see if every part was correctly lined up.

One barge was built for purpose of carrying wood for use on the new dredge. It is all built of pine, frame being 6 by 8 inches, and planking and deck and bottom of 3-inch material. Size of barge is 16 by 60 feet; depth, 3 feet 6 inches; cost of barge, $700.

This dredge and outfit was, when finished, properly laid by for the winter at Grand Forks, Dak., and has a watchman to take proper care of all property connected with it.

This report includes the work only done from June 30, 1881, to November 30, 1881, at the latter date I having been relieved of any charge of the government works on the Red River of the North.

Very respectfully, your obedient servant,

CHARLES WANZER,
Assistant Engineer.

Capt. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

REPORT OF MR. RUFUS DAVENPORT, ASSISTANT ENGINEER.

MOORHEAD, MINN., *June* 6, 1882.

SIR: In reply to your letters of the 19th and 20th of April directing me to collect information relating to the floods, &c., on the Red River, I have the honor to make the following report:

The high water elevations for 1882 were taken at the different points from benches established by former surveys. I have also added high and low water elevations of other years, collected by Wellman, Morris, and others, for the purpose of comparison. The discharges were measured by me, or under my direction, this year.

The gauge readings were commenced at Moorhead and Grand Forks as soon as the ice was affected by the water this spring, and continued during the entire flood. I have taken the low water of 1879 as the standard. The elevations are all given at the height above the sea.

At Moorhead, on April 4, the water stood at 879.7, rising to 899.1 on April 12; on that date the ice moved down river and the water commenced falling. The low water of 1877 was 867.5; low water of 1879, 866.3; low water of 1880, 870.0. The flood of this year was 32.8 feet above the low water of 1879. The flood of 1881 reached an elevation of 894.1, 5 feet lower than that of 1882.

On April 25, the discharge of the river at Moorhead at an elevation of 883.6, 15.5 feet below extreme high water, was 4,269 cubic feet per second. I should estimate the flood discharge at the same point at 20,000 cubic feet per second.

It will be noticed in comparison between the elevations at Moorhead and Grand Forks that the slope during the flood stage is less than at low water, the difference this year being 9.8 feet less at high water; the slope between Grand Forks and Pembina remains about the same as at low water.

At Elm River (Quincy, D. T.) the flood this year reached an elevation of 869.9, 36.2 feet above the low water of 1879; the flood of last year was about 10 feet lower.

Eight miles, by water, below Elm River, 100 feet above the Wild Rice River, I have taken a series of gaugings; the elevations are taken from the Elm River gauge.

Date.	Gauge elevation,	Discharge.
1882.		*Cubic feet.*
May 18	846.6 (23.3 feet below flood)	5,278
23	844.6 (25.3 feet below flood)	4,150
24	844.6 (25.3 feet below flood)	4,016
26	844.4 (25.5 feet below flood)	3,710
27	844.2 (25.7 feet below flood)	3,675
29	843.9 (26 feet below flood)	3,390
31	843.4 (26.5 feet below flood)	3,515

I should estimate the flood discharge at Elm River at about 30,000 cubic feet per second.

At Caledonia the flood reached an elevation of 860.9; the low water of 1879 was 821.3; flood stage, 39.6 feet above low water. The gauge kept at Grand Forks will give a good idea of the continuation of the flood at Caledonia; the high water of last year was 10 feet lower. Mr. Weston, of Caledonia, informs me that the spring floods usually last about ten days; they are sometimes caused by ice gorges, but not often.

At Grand Forks the water reached an elevation of 828 feet, 42.5 feet above low water of 1879; the gauge reading attached will show the duration of the flood.

At Pembina the water reached an elevation of 789 feet. The lowest water of which we have any record was 750.5 (taken by Lieutenant Green in 1879); the low water of 1877 was 752.4; range at Pembina, 38.5. The average velocity of the river between Grand Forks and Pembina during the flood was estimated by river men at 2 miles an hour; with this velocity the discharge would be between 40,000 and 50,000 cubic feet per second. The average height of the banks at Pembina is 787.0. Morris, in 1877, collected the following high-water elevations:

	High water.
May 10, 1873	783.4
April 26, 1874	770.0
26, 1875	779.5
22, 1876	776.9
1877	773.8
June 1877	779.1

The flood of this year all the way from Moorhead to Pembina, except in exceptionally high localities, extended back on the prairie from 3 to 5 miles and from 1 to 5 feet deep, the bottom-lands in the immediate vicinity of the river being from 15 to 25 feet under water; there was little or no current outside of the original channel of the river. The bed and banks of the entire river from Moorhead to Pembina are clay; a little sand is carried into the Red River by the Red Lake River, but is found only a short distance below the outlet of that stream.

As far as I have been able to learn, the ice this year had nothing to do with the high water; there were no gorges worth mentioning, and the flood was entirely caused by the river and valley being inadequate to receive and discharge the vast quantity of water that came from the melted snow.

Very respectfully, your obedient servant,

R. Davenport,
Assistant Engineer.

Capt. Chas. J. Allen,
Corps of Engineers, U. S. A.

Gauge readings at Grand Forks, Dakota, during the flood of 1882.

1882.	Feet.	1882.	Feet.
March 4	4.6	April 15	41.3
31	5.3	16	42.2
April 1	5.5	17	42.7
2	5.5	18	43.0
3	6.9	19	42.1
4	8.2	20	41.3
5	11.3	21	40.4
6	15.3	22	39.4
7	19.0	23	38.0
8	22.3	24	37.4
9	26.4	25	36.5
10	30.4	26	35.4
11	34.3	27	34.0
12	36.8	28	33.1
13	38.1	29	32.0
14	40.7		

0=81.400.
703.5 added to 0 of gauge=height above the sea.

Gauge readings at Grand Forks, Dakota, during the flood of 1882.

1882.	Feet.	1882.	Feet.
May 1	31.1	May 13	19.2
2	27.1	14	19.1
3	25.8	15	18.9
4	24.4	16	18.4
5	23.1	17	18.2
6	21.8	18	17.7
7	20.6	19	17.1
8	20.0	20	16.6
9	20.3	21	16.2
10	19.5	22	16.0
11	19.3	23	15.6
12	19.2	24	15.7

0=81.400.
703.5 added to 0=height above the sea.

Gauge readings at Moorhead, Minnesota, during the flood of 1882.

1882.	Feet.	1882.	
April 4	12.1	April 22	
5	15.0	23	
6	17.9	24	
7	20.6	25	
8	23.7	26	
9	26.5	27	
10	28.6	28	
11	30.6	29	
12	30.6	30	
13	29.1	May 1	
14	27.9	2	
15	26.7	3	
16	26.1	4	
17	25.1	5	
18	23.9	6	
19	22.6	7	
20	21.0	8	
21	19.5	9	

0 = 165.071.
703.5 added to 0 = height above the sea.

COMMERCIAL STATISTICS RED RIVER OF THE NORTH, BETWEEN ABERCROMBIE, DA AND BOUNDARY LINE, DURING SEASON OF 1880.

Carried by—	Pounds carried down stream.	Pounds carried up stream.	Character.
Alsop line of steamers	5,258,854	2,783,965	Wheat, merchandise, wood
Grandin line of steamers	4,497,180	16,680,097	Wheat, merchandise, lumber
Steamer Selkirk	13,596,000	5,148,000	Merchandise, lumber, and wh
Flat-boats and barges	5,150,365		Wheat, lumber, merchandise.
Total	28,502,399	24,612,062	

Total pounds up and down stream, 53,114,461, of which amount 27,009,00 wheat.

The figures above were kindly furnished by Alsop Brothers of the Alsop line B. Shotwell, agent of the Grandin line; and Thomas Owens, clerk of steamer Selk During 1881 there were three steamboats, eight barges, and about forty flat-boats gaged in the carrying trade between Abercrombie and the boundary line. The rying capacity of the steamboats and barges amounted to about 3,000 tons. D 1880 there were eight steamboats and twenty-two barges, with a large number of boats, engaged in the commerce of the river between Abercrombie and Winnipeg. the Canadian authorities having placed an embargo on American steamers run in their waters, the result was that five of the steamers with their barges were drawn and afterwards sold and transferred to parties in Manitoba. The Alsop have this season added another steamboat of 250 tons burden to their line, with bar making now four steamboats and fifteen barges plying on the river.

It is the intention of the Alsop line to put on one of their steamers this fall to between Abercrombie and Moorhead.

The Red River was open and free from ice for a period of two hundred and two da

The following, taken from the Fargo Argus, a leading journal in the Red River ley, gives a good idea of the Red River:

"The Red River is known the world over, but it is usually spoken of in connec with the valley, and few persons stop to think of the river and its importance; the few, by some means, obtain an exaggerated idea, and vainly imagine that it is a sec Amazon, and great is their disappointment and chagrin when they find it is a stre where, in many places, the boats plying thereon cannot turn around, they bein much longer than the river is wide.

"The Red River is the primary cause of the renown obtained by this entire coun the annual rising of the waters assisting in the enriching of the soil. The first indu of the section was the running of the flat-boats upon the river and trading with the dians. The commerce of the present day is large and important, and is constan growing. * * * As an instance, the Grandin arrived here the first of last week from below, and among its cargo was 1,500 bushels of wheat, in sacks, belonging to small farmers along the river. It was sold for $1.35 a bushel, and the proceeds invested in lumber, which was shipped down the river the next night upon the return of the boat.

"The Grandin, upon her first trip down this season, carried $60,000 worth of farm machinery for one firm, and this came from the general agents located at Fargo.

"Most of the merchants in the small towns along the river purchase their goods of the jobbers here, and the boats frequently take out eight or ten car-loads of assorted merchandise which was purchased in this city.

"The lumber trade is a very important item, as a great amount is shipped to Winnipeg and other down-river towns from here. The Alsop line has contracts to carry from 3,000,000 to 5,000,000 feet from here to the capital of the Manitoba province for one firm in the latter place, and expect to complete this by July 1. Nine hundred thousand feet have already been shipped, and ninety-five car-loads are now unloaded ready to go down. They have also carried over 400 tons of miscellaneous freight this season.

"The Alsop Brothers say that local enactments of the Manitoba legislature greatly interfere with their business. It seems, from what they say, that American boats cannot cross the border farther than the first port of entry, but that barges and flat-boats are allowed to go through because the Winnipeggers have very few of these river necessities. On the other hand, neither steamers nor barges can come this side of Pembina. The Messrs. Alsop say they would like to have the river on both sides of the line free, so that boats could do business either in Manitoba or here. Now they load their barges here, take them to Pembina, and they are then taken in tow by a Winnipeg steamer, and their steamer must return without barges. Then they have to furnish boats for the trade across the line as well as this side.

"The last trip down the Grandin carried ten car-loads of lumber and ten of general merchandise. Last year the Grandin brought up 250,000 bushels of wheat—150,000 from the Grandin farm and the remainder for outside parties. This line has five barges, two having been built this spring of 7,500 bushels capacity each.

"The Alsop line has this season built one steamer, the Henry W. Alsop, and one barge, and will have two more upon the docks in a few days. This is in addition to their former barges and the steamer Pluck. Both lines are having all they can do, and report a very brisk and increasing river traffic."

RED RIVER VALLEY—ITS EXTENT.

The extent of the region known as the Red River Valley is stated as about 225 miles east and west by 300 miles north and south. It contains, approximately, 67,500 square miles, or 259,200,000 acres of land, over 80 per cent. of which acreage comprises the finest farming land for the production of cereals and stock-raising in the world. Wheat, corn, oats, rye, barley, and flax are raised in abundant quantities, and with less labor than in the older States and Territories.

V 8.

CONSTRUCTION OF LOCK AND DAM AT GOOSE RAPIDS, ON THE RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA.

This work, its necessities, &c., were given in my report for the year ending June 30, 1881. The estimated cost is $200,000. Congress, by act approved March 3, 1881, appropriated the sum of $20,000 with which to commence the work. This sum was too small to be expended with any advantage at the outset, especially on account of the high price of materials.

No further appropriation having as yet been made, it is not possible to propose any expenditure for the present.

With an already improved channel above the site of the dam up to Abercrombie, and the improvement of the stream below just having been commenced, this lock and dam are absolutely necessary to the people of the valley who are now shipping 25 to 30 bushels of wheat, by river, as against one bushel before any work upon that stream was commenced by the United States.

The sum of $100,000 should be appropriated by the next Congress towards pushing this most important work.

The Red River of the North is within the customs district of Minnesota, with Pembina the port of entry.

The amount of duties collected at Pembina and Saint Vincent during the fiscal year ending June 30, 1882, was $27,236.91.

The total of all other collections, $8,432.08.

For commercial statistics of the Red River between boundary line and Abercrombie, Dak., see annual report for improvement of Red River of the North, Minnesota.

Money statement.

July 1, 1881, amount available	$20,000
July 1, 1882, amount available	20,000
Amount appropriated by act passed August 2, 1882	30,000
Amount available for fiscal year ending June 30, 1883	50,000
Amount (estimated) required for completion of existing project	150,000
Amount that can be profitably expended in fiscal year ending June 30, 1884	100,000

V 9.

RESERVOIRS UPON THE HEADWATERS OF THE MISSISSIPPI RIVER AND ITS TRIBUTARIES.

My last annual report upon reservoirs (see Appendix W 9), Report of the Chief of Engineers for 1881, stated enough of the history of the appropriations for this work to enable one to understand it up to June 30, 1881. By consulting that report and reading with care my three progress reports, published respectively as House Ex. Doc. No. 54, Forty-fifth Congress, third session; House Ex. Doc. No. 39, Forty-sixth Congress, second session; and Senate Ex. Doc. No. 48, Forty-sixth Congress, third session, the whole matter should be plain to any one.

The final commission ordered by the Department of the Interior, and composed of Messrs. Thomas Simpson, of Winona; Albion Barnard, of Minneapolis; and Louis Morell, of the Interior Department, to appraise the value of Indian property likely to be damaged by the construction of the proposed dams at Winnibigoshish and Leech Lake, made their report to the chief of the Indian Bureau at Washington. Their awards being accepted by their department, I received orders in November last to proceed with the work. I placed Mr. Charles Wanzer, assistant engineer, in local charge.

An advance working party was at once started out to repair roads and bridges between Gull River station, on the Northern Pacific Railroad, which point was made an *entrepôt* for supplies, tools, and machinery, and Leech Lake Agency; thence across Leech Lake to the head of Leech River; thence across the swamp, some 17 miles, to the outlet of Lake Winnibigoshish. The road for these 17 miles was cut through heavy timber for a good part of the distance, and the work was necessary in order that the detour across the portage and along the southerly side of Winnibigoshish might be avoided. Following the cutting of the road, the heavy work of forwarding supplies and tools, engines, boilers, pumps, sawmill, pile-drivers, and other machinery commenced. It was necessary to push matters vigorously, in order to take advantage of the ice for crossing Leech Lake, the ground to the eastward of it, barely passable even when frozen, being useless for teams during the warm months. Parties were set at work getting out timber, &c.

Quarters, sheds, and a warehouse were constructed as rapidly as possible, hay secured for the teams and cattle, &c.

The transportation of supplies for the workmen from Gull River to Winnibigoshish was an item, as was the cutting and banking of logs to be sawed and framed.

The lowest offer received for transportation was at the rate of $1.75 per hundredweight; for cutting and banking logs at $5 per M feet B. M., and with guaranty required from the United States.

All offers were rejected and the work was done by the United States. We performed the transportation at $1.49 per hundred weight, 26 cents per hundred weight less than the lowest bid, and the cutting and banking logs at $2.31 per M feet B. M., or $2.69 per M feet B. M. less than the offer. The progress of the work has been excellent. The report of Mr. Wanzer, assistant engineer, who is entitled to great credit for zeal, energy, and efficiency, herewith, gives the details of the work to date. The services of Mr. Albert Wanzer, overseer on the work, also have been highly appreciated.

The award of the commission in regard to the Leech Lake dam was also rendered in October, but before any work could be commenced here it was necessary to obtain releases and franchises in the case of public lands, and withdrawal from market of certain United States lands formerly thought to be Indian lands.

Meddling with the Indians, causing dissatisfaction among them, had also protracted the commencement of work on this dam so that the order to begin the work had not been received by the close of the fiscal year.

Other work consisted in the making plans and sketches for other proposed dams, local examinations, ascertainments, classifications, &c., of lands liable to overflow, a very tedious and unsatisfactory piece of work, assigned to the charge of Mr. C. McClellan, assistant engineer, and in maintaining meteorological and hydrometrical observations.

METEOROLOGICAL AND HYDROMETRICAL OBSERVATIONS.

In connection with surveys and studies of the reservoir system, knowledge of the annual as well as monthly quantity of precipitation and evaporation was of importance, and also knowledge of the discharge of streams. Statistics of rainfall have been collected from the records of old military posts in Minnesota and Wisconsin; from records in the office of the Surgeon-General at Washington; from the records of the Chief Signal Officer for such stations as Saint Paul, Duluth, Pembina, Breckenridge, &c., and from the records of independent stations established by this office at Red Lake, Leech Lake, White Earth, Wausau, Wisconsin; Crow Wing and Taylor's Falls. The information thus collected, assorted, and tabulated is interesting, though time is necessary in which to get such information into the best shape.

The proportion of rainfall and melted snow that actually finds its way into the streams (the residue, in fact, after taking out the items of evaporation, seepage, absorption, the amount for the sustenance of plants, &c.) is one of the important subjects undergoing investigation. Three measuring stations have been established, viz, one at Crow Wing, on the Mississippi River; one on the Crow Wing River, a short distance above its mouth; and one at a point about 6 miles above Taylor's Falls, on the Saint Croix River. Observers at these stations measure the flow of these streams daily, and are provided with apparatus also for noting the rainfall and evaporation. Mr. J. B. Parkinson, assistant engineer, has been in immediate charge of these observations.

The object of the reservoir work is stated in my last annual report for 1881.

The cost of the project, irrespective of damages (an unknown sum), as given in my third progress report upon the reservoirs, is $1,809,083.50. When I say that cost of damages is unknown, I mean that I can give the acreage of overflow by assuming a good margin, the manner of which has been described by me heretofore; but the cost of the acreage or water-powers interfered with, or such buildings, temporary or otherwise, as may be destroyed, I have never pretended to give, being unable to do so. Any one who deals in real estate can understand this, and it is for those who can appreciate these facts, whether real estate dealers or not, that these remarks are made.

Amounts appropriated to date are:

Act approved June 14, 1880	$75,000 00	
Act approved March 3, 1881	150,000 00	
		$225,000 00
Allotment per letter from Office Chief of Engineers, November 9, 1881		1,572 15
Allotment per letter from Office Chief of Engineers, January 20, 1882		176 00
Award to Indians for damages in connection with the building of Lake Winnibigoshish Dam, letter from Office Chief of Engineers, November 8, 1881		8,393 30
Award to Indians for damages in connection with the building of Leech Lake Dam, letter from Office Chief of Engineers, January 20, 1882		7,073 60
Allotted for meteorolgical observations, borings, examinations, &c., letter from Office Chief of Engineers May 27, 1881		7,500 00
Amount available June 30, 1882		*140,713.05

The present Congress having made no appropriation for this work for the next fiscal year, I am unable to say anything about work for the coming year. The sum of $500,000 can be profitably expended during the fiscal year ending June 30, 1884, if this work is to be continued, and if all legal difficulties be removed. The principal difficulties remaining are:

1. Inadequacy of legislation affecting Indian reservations.
2. Omissions in statutes of Wisconsin providing for condemnation of land for United States purposes.
3. Failure of act of Wisconsin legislature to specify or propose distinctly in act approved March 16, 1880, withdrawing from sale State lands liable to damage, &c., terms of settlement for such with the United States.

For commercial statistics reference is made to reports, Falls of Saint Anthony; Mississippi River, above the Falls; Saint Croix River and Chippewa River, Wisconsin.

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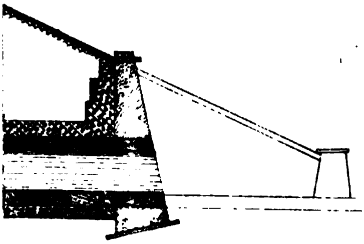
* It is not known at this writing whether the amounts awarded to Indians for damages in connection with the building of Lake Winnibigoshish Dam and Leech Lake Dam are to be paid from the appropriation for reservoirs. If so, then the amount available June 30, 1882, will be $125,246.15.

SHEET № 1



Money statement.

July 1, 1881, amount available		$222,884 91
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$73,389 65	
July 1, 1882, outstanding liabilities	8,782 21	
		82,171 86
July 1, 1882, amount available		140,713 05
Amount appropriated by act passed August 2, 1882		300,000 00
Amount available for fiscal year ending June 30, 1883		440,713 05
Amount (estimated) required for completion of existing project		1,284,088 50
Amount that can be profitably expended in fiscal year ending June 30, 1884		500,000 00

REPORT OF MR. CHARLES WANZER, ASSISTANT ENGINEER.

ENGINEER OFFICE, UNITED STATES ARMY,
Saint Paul, Minn., June 30, 1882.

SIR: The report of the work accomplished under my charge during the last fiscal year upon the reservoirs at the headwaters of the Mississippi River is herewith respectfully submitted.

The work during the year upon the Mississippi River reservoirs proper has consisted in the getting up of the lists of lands liable to overflow by the building of the five reservoirs on its headwaters, and obtaining the ownership of said lands and releases to the government for any claims for damages resulting from their occupancy and flowage by the United States.

The obtaining of the releases has required much time and labor.

After ascertaining the description of lands owned by the government and liable to overflow, it became necessary to find the names of parties to whom any other lands (liable to overflow) had been sold by the government, and then to trace their titles down to present ownership, and from these last parties releases were obtained.

Thus far no remuneration has, on the Upper Mississippi, had to be made to any private parties, all having interests in that section being willing to do their part toward inaugurating the building of the reservoirs by giving free possession of their lands for flowage purposes to the United States; but still the cost of obtaining satisfactory titles and information of ownership has been great.

What the cost of liquidating the damages for the Pine River and Gull Lake reservoir lands will be is not yet known; but undoubtedly these will present more difficulties than those on the Upper Mississippi River proper, on account of the lands being owned in small parcels by different individuals, while on the Mississippi River releases for large tracts belonging to a single firm could the more easily be obtained.

As a result, voluntary releases have been obtained, with some few exceptions, from all private parties owning lands surrounding the Winnibigoshish, Leech, Vermillion, Mud, and Pokegama reservoirs.

The lands around the proposed reservoirs of Gull Lake and Pine River have been listed and described, but so far no releases in these sections have been obtained.

The damages resulting to lands on the Leech and Winnibigoshish Indian reservations were ascertained by a commission appointed by the Interior Department, and an award made by them is supposed to settle all Indian claims for damages that may arise from the building of the Winnibigoshish and Leech Lake reservoirs.

The building of the Vermillion and Mud Lake reservoirs will to a small extent overflow some lands on the Indian reservation, and, should their early building be probable, it would seem that an early settlement should be made with the Indians in some way for the slight damages their reservations might receive from the resulting overflow. I respectfully mention this merely as a point that may arise, not that any actual damages will in my opinion accrue to these small amounts of low river-bottom lands.

On December 25, 1881, under your orders, I left Saint Paul with a small party to commence operations on the building of the Lake Winnibigoshish reservoir; a party to repair the old road from Gull River to Leech Lake and to cut a new road for winter use from the foot of Leech Lake to the dam-site at the foot of Lake Winnibigoshish, having started out early in December. The cutting of the new road was considered necessary in order to shorten the haul of supplies, and also to avoid the exposure to men and teams that would have to be encountered by hauling on the ice over Lake

Winnibigoshish. This new road was completed on January 5, 1882, 17 miles being the length of the newly-made road, and the average cost per mile being $44.65.

On January 9, 1882, the first tree was cut and the building of shelter for stock and men commenced. Also, on that date, the first load of freight and supplies arrived at the dam-site, through from Gull River. Since January 9, the following buildings and quarters have been constructed: Two barns, sizes 30 by 40 feet, material used being logs; four sleeping quarters, sizes 18 by 40 feet and 24 by 40 feet; one eating-house, size 24 by 40 feet; one kitchen, size 18 by 24 feet; two warehouses, sizes 24 by 40 feet and 22 by 28 feet; one ice-house, size 30 by 30 feet; two blacksmith shops, sizes 24 by 30 feet; one saw-mill building, size 35 by 85 feet; one tool-house, size 24 by 24 feet; one building for headquarters for assistant engineer and business office in conducting the work, and also intended to be used as permanent quarters for the dam-tender after completion of the work, size 24 by 36 feet. All the above buildings are constructed of logs with the exception of the last mentioned, which is built of rough boards and has a shingle roof. The roofs of other buildings are made of boards and covered with tar-paper to make them more easily shed rain. The total cost of labor and material used in constructing buildings is $2,117.

Three barges have been built, two of which are 80 feet long, 15 feet wide, and with a depth of 4 feet 6 inches, and one for use in pile-driving, the size of which is 18 by 40 by 3 feet depth of hold. One steamboat has been purchased and is now at work transporting material and supplies. Size of steamboat is 111 feet over all. Cost was $6,500.

It was deemed advisable to lay in during the winter, as far as possible, all necessary supplies and material to be used in constructing the reservoir. Informal proposals were received from various parties offering to do this work for the government. The lowest bid offered was at the rate of $1.75 per 100 pounds from the railroad at Gull River to the dam-site. All bids were rejected on the grounds that the prices demanded were excessive, and accordingly the government undertook to do the work both by private bargain and by teams and labor hired by the day. The lack of snow during the months of January and February added materially to the expenses of the transportation.

Five hundred and nine thousand four hundred and twenty-six pounds of freight (including provisions, tools, materials, and plants) were hauled to the work, a distance of 105 miles, at a total cost per 100 pounds of $1.49.

One million five hundred and ninety-one thousand eight hundred and fourteen feet (board measure) of logs were cut and banked during the winter. This work was done on the Mississippi River near its inlet into Lake Winnibigoshish, on the west side of the lake. The greater part of these logs are of white pine and of good quality. Cost of cutting and banking the logs was at the rate of $2.31 per thousand feet. The lowest price for which this work was offered to be done by contract was $5 per thousand feet, which bid was also rejected, and, as it has turned out, the government has been able to do the work for less than one-half of prices offered by contractors.

The steamboat tows these logs (made into rafts) across the lake to the dam-site, where they are sawed by the mill now built and located there by the United States. One million feet of these logs have been already towed to the mill and 800,000 feet of these have been sawed into dimension material for use in construction of the dam. The cost of sawing is about $2.25 per thousand feet.

Fifteen hundred piles for foundation and sheet-piling supports have been cut and banked and delivered at the work.

Two hundred and fifty tons of ice were gathered and housed during the winter for the use of the men engaged on the work.

Four hundred and forty bushels of charcoal have been burned and manufactured: cost, 20 cents per bushel.

Three hundred and ten cords of wood have been cut and banked for the use of the steamboat and mill, &c. Average cost per cord, $1.50.

The first pile-driving on the dam commenced on April 22, since which time about 400 piles have been driven and 1,000 sheet-piles have been used in building coffer-dams. Of all these piles accurate records of fall and weight of ram and penetration of piles have been kept, in accordance with your instructions.

Ten thousand cubic yards of earth have been excavated for foundations.

Eleven hundred cubic yards of puddle-wall have been placed in the dam.

Five thousand cubic yards of earth embankment have been made in the dam, exclusive of puddle-wall.

One hundred and sixty feet of west end of dam is about completed, and 260 feet more have been coffer dammed and all porous and dangerous material has been removed, and the puddle wall and embankment is now being placed in position.

Two hundred and sixty cubic yards of rock have been gathered and broken to proper size for riprap and filling for cribs.

The necessary plant for this work is large and was hauled by teams over the road during the winter. The total cost of plant, including steamboat, saw-mill, pumps, and pump-engines, pile drivers, and all materials, such as lines, blocks, shovels, &c., is about $24,000.

I believe that from this time the construction of the dam will proceed very rapidly. Prior to this time, the getting ready to do work has consumed much of the labor of the force employed.

The starting of so large a piece of work at such a distance from any of the ordinary business facilities has been necessarily slow and expensive. But I see no reason why with ordinary good fortune the work may not be nearly, if not entirely, completed this fall, and for the amount of money originally estimated by you. Any other reservoir on the Upper Mississippi could now be started with far greater ease and less expense as to plant than has been required in commencing the work at Lake Winnibigoshish; and the experience derived from doing this work by days' labor will enable the government to profit by the past and possibly do better in the future. The cost of all material, labor, and provisions of all kinds has very much increased during the past year, which will add materially to the cost of the work.

Indians have been employed on the work to as great an extent as economy would dictate, and they have generally proved themselves faithful and satisfactory laborers.

Very respectfully, your obedient servant,

CHARLES WANZER,
Assistant Engineer.

Capt. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

V 10.

SURVEYS FOR RESERVOIRS AT SOURCE OF THE MISSISSIPPI AND ITS TRIBUTARIES.

As stated in my last annual report it is necessary, in order to meet incidental questions that are constantly arising, to continue hydrological observations at the outlets of several well-defined basins, to make borings at the sites of reservoirs where such have not yet been made, to recontour some of the sites, to work up records, data, maps, drawings, and estimates. The cost of such examinations for one year would be about $49,000, as stated in the last annual report.

There being no appropriation for such work during the last fiscal year, nothing of the sort was done under this head.

Amount than can be profitably expended in fiscal year ending June 30, 1884. $49,000

V 11.

EXAMINATION OF CANNON RIVER, MINNESOTA, WITH A VIEW TO ITS BEING ADDED TO THE RESERVOIR SYSTEM OF THE UPPER MISSISSIPPI.

ENGINEER OFFICE, U. S. ARMY,
Saint Paul, Minn., December 9, 1881.

GENERAL: I have the honor to render the following report upon the examination of the Cannon River, as required by the terms of section 2, river and harbor act, approved March 3, 1881. The act reads:

> The headwaters of the Cannon River, in Minnesota, with a view that the same may be added to the reservoir system of the Upper Mississippi.

The amount of funds available from the general appropriation for examinations and surveys being necessarily small in proportion to the work required, a general examination of the most prominent parts of the Cannon River basin only could be made in connection with a study of existing State and county maps and some data extant.

Mr. J. P. Frizell, assistant engineer, was charged with the immediate examination of the ground. His report is herewith.

By inspection of the report it appears that the drainage area tributary to the river is about 1,350 square miles.

The average annual precipitation at Saint Paul is about 30 inches, and assuming that the precipitation over the drainage area of the Cannon River is not less than that at Saint Paul, and that one-third of it finds its way into the stream, we should have an annual supply of about 31,350,000,000 cubic feet, equivalent to a uniform discharge of about 1,000 cubic feet per second throughout the year.

Assistant Frizell notes the waste in the early part of the past season of something over 3,000,000,000 of cubic feet of water at Faribault alone for want of means to control and utilize it in the interest of mills at that point, equivalent to about 110 cubic feet per second for an entire year, or for 100 days about 400 cubic feet; and is of opinion that reservoir capacity for upwards of 5,000,000,000 cubic feet can be obtained at the lakes feeding the stream above Northfield.

Until full examinations and surveys can be made, however, nothing like a definite estimate of the public benefit to be derived from, or the cost of, such reservoirs can be rendered.

The low-water discharge of the Cannon River is not, at present, known.

In a report upon this stream, published as House Ex. Doc. No. 58, Thirty-ninth Congress, second session, 1867, a gauging is reported at a point just above the mouth of the Little Cannon, showing a discharge of about 40,000 cubic feet per minute, or about 666 cubic feet per second.

The corresponding discharge into the Mississippi would, of course, be greater.

The stage of water at the time the gauging referred to was made was above that of low-water.

An increment of a few hundred cubic feet per second to the low-water discharge of the Mississippi River below the mouth of the Cannon would not, of itself, be of value to the navigation of the former.

If the reservoir system ever attains the development of which it is believed capable, the Cannon, like other streams of similar size and watershed, would necessarily be included.

The power of the stream is now largely utilized in operating flouring mills at Morristown, Faribault, Northfield, and other points, and it seems more than probable that reservoirs, to be operated solely in the interest of navigation, would, at this present, be more detrimental to the milling interests than of benefit to the public.

The report of Mr. Frizell and the letter of Mr. Bean, herewith, furnish evidence of the manufacturing interests dependent upon the power of the stream. No statistics pertaining to the Mississippi have been presented, as such are contained in the reports of the officer in charge of the improvement of that river.

I inclose with this a sketch of the river and its sources above Northfield, drawn on a scale of one-third inch to the mile.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. JOSEPH P. FRIZELL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Saint Paul, Minn., August 27, 1881.

SIR: Cannon River rises in Rice County, Minnesota, being the outlet of Shields Lake.

It flows westerly into Le Sueur County, then turning to the eastward re-enters Rice County, and passing through Rice, Dakota, and Goodhue counties joins the Mississippi at Redwing, some 40 miles below Saint Paul.

It drains an area of about 1,350 square miles, lying mostly 300 or 400 feet above the Mississippi at Redwing.

As might be expected, the waters furnish in this descent numerous opportunities for the development of water power. Mills, devoted mainly to the manufacture of flour, are in operation at many points on the stream, notably at Morristown, Faribault, Cannon City, Dundas, Northfield, Waterford, Granville, and Cannon Falls. The owners of these mills are associated in what is called the Cannon River Manufacturers' Association, a corporation originally chartered by the State of Minnesota under the name of the Cannon River Improvement Company, for the purpose of making the river navigable by means of locks and dams. Its present purpose is the improvement of the river, in respect of water power, by the construction of storage reservoirs. Some surveys have been made by this company, the results of which have been communicated to me by their engineer, Mr. R. H. L. Jewett, and form a part of the data of this report.

It is understood to be at the instance of this association that these examinations are made, they alleging that reservoirs on this stream would be as beneficial to the Mississippi as at any other point, and, at the same time, would be of great incidental benefit to the manufacturing interests on the stream.

In accordance with your instructions, I have visited and examined nearly all the lakes suggested as reservoirs, and have procured and studied the county maps of this region, from which much valuable information is derived.

The peculiarity of the upper part of this stream is a chain of lakes through which it flows at intervals, during the first 50 miles of its course. It issues, as above stated, from Shields Lake, which lies in close proximity to Mud Lake and Lake Mazaska. The three together cover something like 4 square miles. The last-named lake has no open connection with the others, though one could easily be made.

These lakes command but a small drainage area, and would probably be of little value as reservoirs.

Next below comes Rice Lake, containing some 300 acres. Then comes Lake Dora, containing some 700 acres, which might be flowed by a dam across the Cannon, forming, with adjacent marshes, a reservoir of probably 1,000 acres. Farther down, we come to Lake Gorman, containing some 500 acres, which might be raised 15 feet, forming, with adjacent lakes and marshes, a reservoir of over 1,000 acres in area. Next we come to Sabre Lake, containing some 275 acres, that might be flooded to the depth of 12 or 15 feet. Next comes Lake Tetonka, containing over 1,400 acres, and Sakatah, of about the same area.

These could both be raised by a single dam, the only serious impediment to such a project being the little village of Waterville, at the head of Lake Sakatah.

This might be defended by a dike and drained by windmills at a moderate expense.

Next below the last-named comes Cannon Lake, containing 1,300 acres, then Wells Lake, containing, with adjacent marshes, some 500 acres.

These are both controlled by the dam of the Polar Star Mill, at Faribault, which might be raised considerably higher. All these lakes lie on the main stream, which would probably supply all the water that the lakes could hold at any practicable elevations of their surfaces.

The following lakes lie on tributary streams, namely: at the head of the Little Cannon, which enters the main stream above Lake Tetonka, are Lakes Jefferson, German, and Bossuot, all controllable by one dam and containing, in the aggregate, with adjacent marshes, about 4,000 acres. Horseshoe Lake, discharging into the Cannon below Lake Sakatah, contains over 400 acres, and could be raised 6 feet or more by a very inexpensive dam.

Mud Lake, at the head of Devil Creek, contains over 400 acres, and commands a considerable drainage area. Roberd's Circle and Union lakes contain, in the aggregate, over 2,000 acres, and command considerable drainage grounds. The first discharges into the Cannon above Faribault; the two latter between Faribault and Northfield.

There are no sites for reservoirs on the main stream below this point. The Straight River joins the Cannon at Faribault. This drains a region of some 400 square miles in area, being nearly the whole of Steele County. No eligible sites for reservoirs are known to exist on this stream.

From the dimensions of the wasteway of the Polar Star Mill, at Faribault, and the statements of the proprietors as to the depth and duration of the flow, it appears that something over 3,000,000,000 of cubic feet of water ran to waste there in the early part of the present season, calling for a reservoir capacity of 4,000,000,000 or 5,000,000,000, in order to reduce the stream, at that point, to a uniform volume at all seasons. Th indications are that this amount could be obtained at the several lakes above mentioned.

The subsoil throughout this entire region is a clay gravel, furnishing excellent fou dations for hydraulic embankments, and admirable material for the construction the same.

The fall from Faribault to the Mississippi, as appears by the levels of the Milwauk and Saint Paul Railroad, is something over 300 feet.

There can be no question as to the value of this system of reservoirs to the manu facturing interests on the Cannon River. The quantity of water wasted at the Pol Star Mill would, if impounded in reservoirs and drawn according to necessity, furnis 100 cubic feet per second for an entire year. The numerous mill-ponds on the strea in connection with the great reservoirs of Wells and Cannon lakes, immediately abov Faribault, would furnish the means of concentrating this quantity into the workin hours of the secular day, giving for purposes of water power 200 cubic feet per secon This, on the total fall above stated, would give, after making due allowance for losses head, nearly 5,000 horse-powers, worth, for milling purposes, about $100,000 per annum though this by no means represents the total increase of power due to such a syste of reservoirs. This estimate assumes, of course, that the system of reservoirs could used wholly in the interest of manufacturing, and that the entire fall of the stream utilized, as it undoubtedly will be in a few years.

The above refers to the system of reservoirs above Faribault. Those which dischar into the river below that point would be of additional benefit. It must be remem bered that a stream flowing from a clay region like this is much more susceptible benefit from reservoirs, and much less valuable for mill purposes without such agen cies, than a stream flowing from a sandy district. The ground acts as a reservoir to much greater extent in the latter case than the former, and the fluctuations of volum do not take so wide a range.

As to the benefit to the navigation of the Mississippi to be expected from this sys tem of reservoirs, it is to be observed that the opportunities offered here for the sto age of a limited quantity of water are perhaps as good as some that have been exam ined and surveyed. A system of reservoirs on a sufficiently extended scale to reduc the flow of the Upper Mississippi to uniformity, or any decided approach thereto, woul necessarily include these sites. No occasion can be perceived, however, for immedi ate action in the matter, as more favorable sites have been surveyed in sufficient num ber to absorb all the funds likely to be devoted to this use for many years.

As to whether this system of reservoirs could at the same time be of full benefit the Mississippi River and also to the interests of manufacturing on the Cannon, the are the following observations to be made:

Reservoirs are expected to be of benefit to the Mississippi in two ways:

1. By restraining floods.
2. By increasing the low-water volume.

As regards the first function, all reservoirs are equally beneficial. As regards th second, reservoirs controlled in the interest of navigation might, and under any ci cumstances likely to arise would, be so used as to be of little benefit to manufacturing and *vice versa*. The interests of manufacturing are best served by a uniform volume the stream at all seasons.

The interests of navigation on the Mississippi would usually require the conten of the reservoirs to be discharged in the course of two to four months and the tot flow of the stream to be held back during the rest of the year. Rivers in Minneso are peculiarly liable to low-water in the winter. Mills on the Cannon River ha much trouble from this cause last winter, as did those at Minneapolis and elsewher It is obvious that reservoirs operated in the interest of navigation could be of benefit to manufacturing during this period, no discharge being required. Moreove the appropriation by the government of all the available reservoir sites on the strea for the purpose of improving the Mississippi, would forever put it out of the power manufacturers to realize the full benefits of the storage of water.

The divergence between the use of reservoirs as aids to navigation and their use aids to water-power may be expected to grow less and less as the reservoir system extended. If we should suppose the system carried to its ultimate extent, the exte of impounding all the water of the river, or of its upper part, this divergence wou disappear altogether.

In that case the river and all its tributaries would be reduced to a uniform, or near uniform, flow at all seasons of the year, a condition alike favorable to navigatio manufacturing, and all other interests, and all reservoirs, for whatever purpose co structed, would contribute equally to this result. At some future time such a con tion may be realized, but it is now too remote for consideration in this connection.

Very respectfully, your obedient servant,

JOS. P. FRIZELL,
Assistant Engineer.

CHAS. J. ALLEN,
Captain of Engineers and Bvt. Major, U. S. A.

APPENDIX W.

IMPROVEMENT OF TENNESSEE AND CUMBERLAND RIVERS AND OF RIVERS IN EASTERN TENNESSEE AND GEORGIA.

REPORT OF MAJOR WILLIAM R. KING, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882, *WITH OTHER DOCUMENTS RELATING TO THE WORK.*

IMPROVEMENTS.

1. Tennessee River.
2. Cumberland River.
3. Hiwassee River.
4. French Broad River, Tennessee.
5. Clinch River, Tennessee.
6. Duck River, Tennessee.
7. Obey's River, Tennessee.
8. Caney Fork River, Tennessee.
9. Coosa River, Georgia and Alabama.
10. Oostenaula and Coosawattee rivers, Georgia.
11. Etowah River, Georgia.
12. Ocmulgee River, Georgia.
13. Oconee River, Georgia.
14. Red River, Tennessee.
15. South Fork Cumberland River, Kentucky.
16. Little Tennessee River, Tennessee.

EXAMINATIONS AND SURVEYS.

17. Bear Creek, running from Northeast Mississippi into the Tennessee River.
18. Little Tennessee River, from its mouth on the Holston or Big Tennessee River to the mouth of Tellico River.
19. Chattahoochee River, between West Point and Bolton.

UNITED STATES ENGINEER OFFICE,
Chattanooga, Tenn., August 31, 1882.

GENERAL: I have the honor to submit annual reports on the works under my charge for the fiscal year ending June 30, 1882.

Very respectfully, your obedient servant,

W. R. KING,
Major of Engineers.

CHIEF OF ENGINEERS, U. S. A.

W 1.

IMPROVEMENT OF TENNESSEE RIVER.

I. ABOVE CHATTANOOGA.

The following brief historical sketch and description of the work taken from last Annual Report, will give, in a few words, the necessary introduction to the report of last year's operations:

In 1830 a careful examination of the Holston and Tennessee rivers between Kingsport, Tenn., and the Alabama State line, was made by Col. S. H. Long, United States

Topographical Engineers. This examination included the 189 miles between Knoxville and Chattanooga, now designated "the Tennessee River above Chattanooga," and the report, which was reprinted in 1875, gives a detailed description of every obstruction to navigation, forty-three in number, at that time, and plans and estimates for their improvement.

In 1852 Congress appropriated $50,000 for the improvement of the navigation of the Tennessee River, and some of the dams built under this appropriation are still in existence, though generally covered up by the more extensive work of recent improvement.

In 1871 the sum of $35,000 was made available from the appropriation for the improvement of Tennessee River, below Chattanooga, and with that and subsequent appropriations the work has been continued from year to year during the low-water season until the present time.

The bed and banks of this river are remarkably permanent, and have been but little changed by the floods of the last fifty years, as shown by the report and map of Colonel Long's examination.

The obstructions consist of shoals of sand and gravel, reefs of rock, snags, &c., and the principal improvement consists in excavating a channel through the reefs and increasing the depth of water at the shoals by means of stone wing-dams so constructed as to narrow the channel and cause it to scour deeper or become deeper by the additional volume of water thrown into it.

The dams are generally made of heavy stone founded upon rock, and, not being subject to damage by ice, as in most northern streams, they are practically permanent structures, and the channel excavations seldom show signs of filling up.

The improvement when once completed will therefore require but little expense for repairs for many years to come. Some of the dams have already withstood the floods of eight or nine winters without serious damage. Most of the damage experienced has been traced to defective connections with the shore, which has since been remedied, and to the wanton destruction caused by parties who make holes in them for the passage of small boats to save themselves a little distance in rowing.

Of the twenty-nine obstructions requiring improvement, twenty-two have been practically removed, and others have been more or less improved.

Little River Shoals occupied the working force during the four months of active operations, and when work was suspended for want of funds it was found that about 10 inches had been gained in the depth of channel, which will probably answer for the present.

Two thousand seven hundred and ninety-two cubic yards of rock were quarried and used in building dams and protecting the banks from abrasion by the current.

The work was in local charge of Assistant Engineer J. S. Crary, with an average daily force of forty-one men.

In August soundings were taken at Williams Island Shoals, with a view to beginning work at that obstruction, which, together with Lyons Shoal, will be improved with the funds now available. These shoals should be improved at once, and work should then be directed to the removal of several minor obstructions that have been passed over in getting at the more serious ones.

It is hoped that the entire amount asked for will be appropriated at once, as smaller appropriations are necessarily more costly in the end, owing to the undue expense of starting and closing up the work, watching and caring for boats and other property, &c.

The following figures (all the data that could be obtained) show in part the amount of commerce at "the landing," Chattanooga.

Freight:

Iron ore	tons	20,851
Limestone and building stone	do	11,638
Grain	do	3,761
Hay	do	307
Coal	do	32,000
Sand	do	6,412
Miscellaneous	do	5,650
Wood	cords	3,000
Lumber, including poplar, pine, gum, oak, and walnut	feet	12,000,000

The estimated cost of improving the Upper Tennessee River, as made in 1872 and 1874 and modified in 1877, was	$225,000 00
Amount appropriated	215,500 00
Amount expended	208,462 30

Money statement.

July 1, 1881, amount available		$5,727 10
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$5,676 41	
July 1, 1882, outstanding liabilities	12 99	
		5,689 40
July 1, 1882, amount available		37 70
Amount appropriated by act passed August 2, 1882		7,000 00
Amount available for fiscal year ending June 30, 1883		7,037 70
Amount (estimated) required for completion of existing project		9,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.		9,500 00

II. BELOW CHATTANOOGA.

This portion of the Tennessee River, 453 miles in length, is now navigable excepting at the Muscle Shoals, where about 23 miles of obstructions are in process of removal. The completion of this work will connect 425 miles of navigable water in the Tennessee above the Muscle Shoals, besides hundreds of miles in its navigable tributaries, with 255 miles of river below Muscle Shoals, and thence with the entire Mississippi system.

As early as 1824 Mr. Calhoun, then Secretary of War, mentioned the canal around Muscle Shoals as *third* in rank among the proposed improvements of national importance. In 1828 surveys were made with a view to building a canal around the Muscle Shoals, and Congress donated 400,000 acres of land to the State of Alabama for building it, but the canal was never properly completed and went into disuse soon after it was opened.

In 1867 an examination of the river from Chattanooga to Paducah was made, and in 1872 an instrumental survey of the shoals was completed, upon which the present project for the improvement was based; modified, however, by a resurvey of the Elk River Division in 1877.

The existing project consists in enlarging and rebuilding the old canal, 14½ miles long; extending the improvement around the Elk River Shoals, about 8 miles, and Little Muscle Shoals 5 miles long; and in removing a number of minor obstructions in the navigable portions of the river, both above and below these great obstructions. For this purpose the estimates were $4,133,000, and with annual appropriations of even one-half of the amounts of the estimates the river would now be navigable, and the commerce of North Alabama and East Tennessee would be joined to that of the Mississippi Valley.

The appropriations have, however, been less than one-third of what could have been profitably expended, and the period of completion has consequently been delayed for several years.

1. ELK RIVER DIVISION.

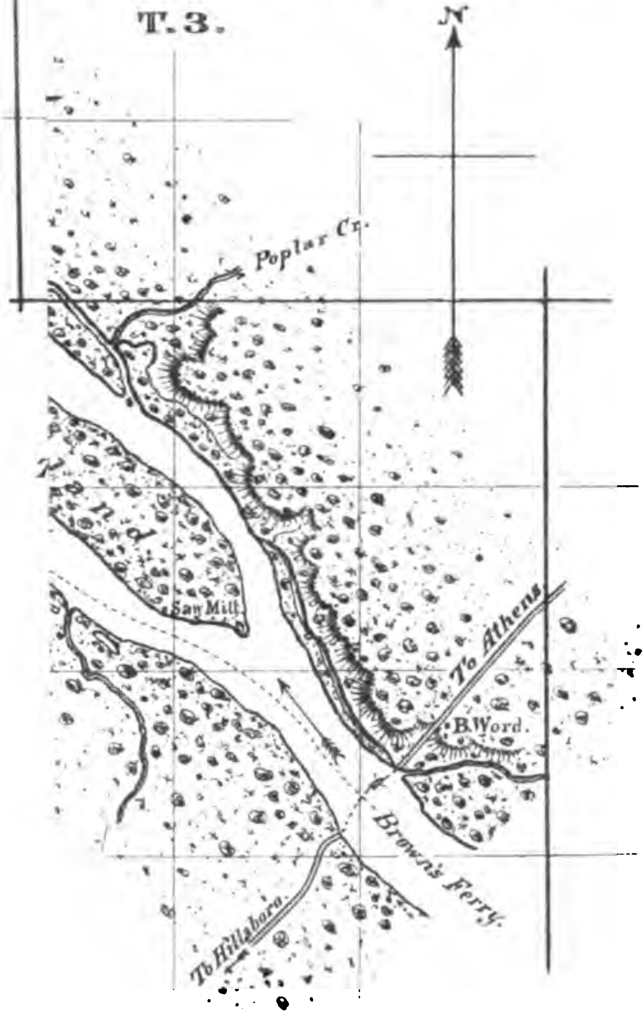
As will be seen from the map (sheet 1), this part of the improvement is made partly by channel excavation and retaining dams, and partly by a canal with two locks.

The channel excavation, opposite Brown's Island, where the bed of the river required more or less blasting out for a distance of nearly 2 miles, requiring the removal of 39,750 cubic yards of rock, was accom-

SHEET 1.

NOTE.

C Rock Excavation completed.
C Stone Dam 1/8 completed.
Lock A Dam nearly completed.
A Pit excavated and Stone cut.
B 3/8 of Stone cut.
al Trunk between Locks A and B 1/7 completed.
res in Brackets - thus (12) give elevation of Water
nal above Low Water Mark at Lock B.



Some little work was also required to repair the damage caused by a very unusual flood, and to keep the buildings, tools, and machinery in order for the continuation of the work.

The Blue Water Division was carried on under Assistant Engineer H. J. Gielow, and Shoal Creek Division under Assistant Engineer Robert Hooke, both on the hired labor system, and the progress of the work has been excellent until the end of May, when active operations were suspended for want of funds. The appropriation of August 2 having become available, the work is now under good headway.

The following was the condition of the various parts of the work at the end of the year:

Lock No. 1, guard lock, 10-feet lift.
Lock No. 2, 6-feet lift.
Lock No. 3, 12-feet lift.
Lock No. 4, 10-feet lift.
Lock No. 5, 12-feet lift.
Lock No. 7, 13-feet lift.
} The masonry of these six locks is *completed* and they are ready for the gates.

Lock No. 8, 12-feet lift, seven-eighths masonry laid.

Lock No. 9, 10-feet lift. One side of this lock is to be natural rock in position; one-half of the stone cut, and one-fifth of the masonry laid.

Lock No. 10, 10-feet lift. This forms the outlet into the river, and is founded 6 feet below extreme low water. The site has been inclosed in a coffer-dam and seven-eighths of the foundation excavated and seven-eighths of the stone cut for the lock.

The masonry of the Shoal Creek Aqueduct, consisting of twenty-five piers, 75 feet long, 11 feet high, and 3 feet thick, and two abutments, is completed.

At Blue Water Creek the seven piers and two abutments, each containing about 36 cubic yards of rock-face masonry, required as buttresses to sustain a dam 288 feet long across the mouth of the creek, and to carry the bridge required at that point, have been completed, and a substantial bridge of timber and iron has been built upon them.

3. LITTLE MUSCLE SHOALS DIVISION.

No work was done on this division during the year, and but little, if any, will be required before the canal around Big Muscle Shoals is opened to navigation.

4. OBSTRUCTIONS BELOW FLORENCE.

In September a steam snag-boat was fitted out and a small force organized under Assistant Engineer C. A. Locke, for the purpose of removing snags and other obstructions between Florence and the mouth of the river. The stage of the river was favorable at first, but after working as far down as Duck River Shoals a rise occurred and the party was disbanded on the 12th of November. Seventy-five snags over 10 inches in diameter, and about four hundred smaller ones, were removed, including among the former some that had been the terror of steamboat men for many years.

It is proposed to resume operations with this force at once, as the river is now for the first time getting low enough for the purpose, and continue, if possible, to the mouth of the river, removing such of the troublesome snags as can be handled to advantage, and doing any other light work of like nature that will be of special advantage to navigation.

I am indebted to J. C. Cobb, esq., of Paducah, Ky., for the following statistics of the commerce and navigation of the Lower Tennessee River. Mr. Cobb writes that the—

Number of boats employed in Lower Tennessee River from July 1, 1881, to July 1, 1882, viz:

Five packets with an aggregate capacity of 3,000 tons made regular weekly trips, and five tow-boats with barges, having a combined capacity of 10,000 tons, made irregular trips.

These boats transported from Tennessee River during the same time the following, viz:

200,000	bushels peanuts.
25,000	bales of cotton.
1,000	tons cotton-seed.
1,000	hogsheads leaf tobacco.
1,000	cords handle timber.
1,000,000	cut stones.
20,000	cords hub timber.
10,000,000	shingles.
7,000,000	feet cut lumber.
7,000	tons pig iron.
500	tons leather.
1,000	tons handles, singletrees, &c.
10,000	barrels lime.
5,000	tons miscellaneous freight.

Large quantity manufactured tobacco and they transported into that river during same period viz:

50,000	sacks corn.
30,000	barrels salt.
50,000	barrels flour.
1,000	tons hay.
20,000	tons assorted merchandise.

During the year 10,000,000 feet lumber in logs were rafted or floated out of the river and 1.250,000 white-oak staves for foreign markets were transported in flat-boats to New Orleans.

In consequence of the drought of 1881, shipments from the Tennessee River for the past year, were below an average, while those into that stream, especially breadstuffs and provisions, were greater than usual.

The new appropriation and that herein asked for should be expended in continuing operations at Muscle Shoals, and improving navigation at minor obstructions on the balance of the river between Chattanooga and Paducah.

The Tennessee River is in the collection district of New Orleans. Chattanooga, Tenn., is the nearest port of delivery, and the amount of revenue collected there during the fiscal year 1881–'82 was $22,689.17.

The original estimates of cost of improving Tennessee River below Chattanooga were	$4,133,000 00
Amount appropriated	2,345,500 00
Amount expended	2,086,647 84

Money statement.

July 1, 1881, amount available		$271,849 39
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$261,599 15	
July 1, 1882, outstanding liabilities	1,398 08	
		262,997 23
July 1, 1882, amount available		8,852 16
Amount appropriated by act passed August 2, 1882		250,000 00
Amount available for fiscal year ending June 30, 1883		258,852 16
Amount (estimated) required for completion of existing project		1,787,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.		700,000 00

W 2.

IMPROVEMENT OF CUMBERLAND RIVER.

As early as 1830 the States of Tennessee and Kentucky made appropriations for the survey and improvement of the Cumberland River, and in 1846 a company was chartered by the former State to build locks and dams on the river below Nashville.

The existing project was based upon a survey authorized by Congress in 1870, and as to Smith's Shoals, upon a resurvey of those obstructions made in 1875. A survey of the Falls of the Cumberland was also made in 1879 and a reconnaissance of the Upper Cumberland in 1880.

The different appropriation bills have divided the Cumberland into a number of sections, which will be considered in their order, but it may be premised that the nature of the obstructions is in general terms the same in all parts of the river, viz, shoal water, rapid currents, snags, and overhanging trees, and in the upper section, "above the Tellico," mill-dams.

The method of improvement consists of blasting out and otherwise removing the ledges and loose rock, scraping and washing out the sand and gravel bars, and removing snags and overhanging trees.

The method of improvement by locks and dams, which is the only one by which a low-water navigation can be secured above Nashville, or in fact below Nashville, excepting for small steamboats, has heretofore been considered too expensive to be undertaken, and the present plans are designed to give additional depth at medium stages of the river, and to prolong the season of navigation. As stated in a former report, there are some 9 steamboats of from 300 to 500 tons, and 5 from 125 to 260 tons, engaged in commerce on the river, running between Nashville and various points on the Cumberland, Ohio, and Mississippi rivers.

During the high-water season the smaller of these boats also ascend the Caney Fork and Obey's rivers.

The Cumberland River is navigable for all of the above steamboats for six months in the year from Nashville to the mouth of the river; from six to eight months from Nashville to the mouth for boats drawing 3 feet or less; from nine to ten months from Nashville to the mouth for boats of about 20 inches draught. Distance, 192 miles.

Above Nashville, the Cumberland is navigable to Point Burnside (crossing point of Cincinnati Southern Railroad), a distance of 358 miles, for from four to six months for steamers of 3 feet draught or less, and from two to three months for larger boats.

From Nashville to Bucksville, 230 miles above, the Cumberland is navigable for from five to seven months for steamers of 3 feet draught or less, and from three to five months for larger boats.

From Nashville to Carthage, 120 miles above, the Cumberland is navigable from six to eight months for steamers of 30 inches draught or less, and from four to five months for larger boats.

Flat-boating is not carried on extensively upon the Cumberland, except to bring out coal from points above Point Burnside, and this is only practicable during occasional high stages of the river, about four or five during the year. A small quantity of produce and some tobacco find their way to market by aid of the flat-boats.

The following are the details of the work done during the past year on the different sections, as reported by Capt. L. C. Overman, United States Engineers, the officer in immediate charge of this improvement.

All this work is done by hired labor, there being no surveys of sufficient accuracy to protect the government interests in a written contract.

I. BELOW NASHVILLE.

Work on this section was begun in July, and continued until the appropriation was exhausted in October, at the following obstructions, viz: Dover, Middle Gatlin, Lower Gatlin, Race Track, and Little River Shoals, which are from five-eighths to nineteen-twentieths completed. The following are the quantities of work done:

6,393 cubic yards of rock quarried.
9,386 cubic yards of rock built into dams.
67 cubic yards of rock excavated from channel.
305 cubic yards of gravel excavated from channel.
583 snags and roots removed by two snag-boats.
Average daily force of men employed, 95.

The bar referred to in last report as having formed in the Ohio River between Cumberland Island and the Kentucky shore, about 2 miles below Smithland, effectually prevented steamboats from entering the mouth of the river until a rise occurred sufficient to give the necessary depth of water. Some efforts were made to reduce the bar by scraping with a small steamboat, but very little was accomplished in the ten days during which the boat was so employed, and the appropriation having been practically exhausted, navigation had to remain suspended, as before stated, until a rise occurred.

The new appropriation and that herein asked for can be profitably expended in continuing the improvement of the shoals between Nashville and the mouth of the Cumberland in accordance with the plans already described.

The original estimate of cost of improving Cumberland River below Nashville was	$248,8
Amount appropriated	235,0
Amount expended	220,0

Money statement.

July 1, 1881, amount available		$13,617 0
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$13,579 12	
July 1, 1882, outstanding liabilities	37 88	
		13,617 0
Amount appropriated by act passed August 2, 1882		15,000 0
Amount (estimated) required for completion of existing project		13,821 0
Amount that can be profitably expended in fiscal year ending June 30, 1884		16,000 0

II. ABOVE NASHVILLE.

NASHVILLE TO KENTUCKY LINE.

Work on this section was carried on at Cub Creek, Sand, Bartlett's, Goose Creek, and Whitley's Rock Shoals, which are from one-half to fifteen-sixteenths completed, according to existing project.

The following are the quantities of work reported;

Rock quarried for dams	cubic yards	10,[illegible]
Rock placed in dams	do	12,2
Rock excavated from channel	do	[illegible]
Gravel excavated from channel	do	8,5
Snags removed by two snag-boats	number	[illegible]

Work was continued on this section, from the beginning of the fiscal year, about four months. Average daily force of men employed, 102.

The total amount expended from Nashville to Kentucky line is $39,155.

III. KENTUCKY LINE TO SMITH'S SHOALS.

Work on this section was in progress at the beginning of the year, and continued until stopped by high-water in December, at the following obstructions: Wolf Creek and Harmon's Shoals, and twenty-one other obstructions on the section; the following being the quantities:

Rock quarried for dams	cubic yards	3,789
Rock placed in dams	do	7,048
Rock excavated from channel	do	2,909
Gravel excavated from channel	do	10,609
Snags removed from channel	number	516

The average daily force of men employed was 72.

The new appropriation and that herein asked for can be profitably expended in continuing the improvement of the shoals between Nashville and the foot of Smith's Shoals in accordance with the plans already described.

The total amount expended from Kentucky line to Smith's Shoals is $42,609.

Money statement.

July 1, 1881, amount available		$37,823 74
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$33,727 01	
July 1, 1882, outstanding liabilities	704 50	
		34,431 51
July 1, 1882, amount available		3,392 23
Amount appropriated by act passed August 2, 1882		30,000 00
Amount available for fiscal year ending June 30, 1883		33,392 33
Amount (estimated) required for completion of existing project		51,764 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		52,000 00

IV. SMITH'S SHOALS.

These shoals, consisting of Shadowen Shoals, White Cliff Ripple, Long Shoal, and Mill Shoal, having an aggregate fall of 55 feet in 8 miles, form the most serious obstacle to navigation between the Great Falls and the mouth of the Cumberland, an estimated distance of 591 miles.

The original plan of improvement was based on a survey made in 1875, and contemplated smoothing and narrowing the channel, by excavating reefs and bowlders, and building wing-dams at intervals, so as to facilitate the down-stream passage of coal-boats and rafts, the velocity of the current being too great to admit of up-stream navigation, without recourse to locks and dams.

During the year the essential parts of the work were completed, so that the improvement can now be utilized, and an opportunity has been afforded boatmen to test the efficiency of the work as designed.

A considerable number of boats have passed the shoals in safety during the past season, and the results appear to justify the conclusion that the improvement will answer the necessities of commerce, at least until the balance of the river above Nashville is provided with slack-water navigation.

Active operations were carried on during the months of July and August, with an average daily force of one hundred and nine hired men, when the funds were exhausted, and the force was removed to the section above the mouth of the Tellico.

The principal work was done at Long and Mill Shoals, and consisted of—

3,264 cubic yards of rock quarried.
6,700 cubic yards of rock put in dams.
210 cubic yards of rock excavated from channel.

Two of the dams originally built require shortening, and two others require strengthening and completing, all of which it is thought can be accomplished with the available funds.

The improvement as made may be considered permanent. No additional appropriation is therefore estimated for.

During the year a survey and estimate were made for a system of locks and dams for Smith's Shoals, the report of which was printed as Senate Executive Document 132, Forty-seventh Congress, first session.

The total amount expended on Smith's Shoals is $99,745.37.

Money statement.

July 1, 1881, amount available		$7,070 94
July 1. 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$6,804 31	
July 1, 1882, outstanding liabilities	12 00	
		6,816 31
July 1, 1882, amount available		254 63
Amount appropriated by act passed August 2, 1882		15,000 00
Amount available for fiscal year ending June 30, 1883		15,254 63
The estimates of cost of improving Cumberland River above Nashville (Nashville to the head of Smith's Shoals) were		313,764 00
Total amount appropriated (Nashville to Falls of the Cumberland)		281,000 00
Total amount expended (Nashville to Falls of the Cumberland)		232,353 14

V. CUMBERLAND RIVER, KENTUCKY, ABOVE THE MOUTH OF TELLICO.

An appropriation of $10,000 having been made for this section of the river, a force under Assistant Engineer W. C. Crozer, averaging fifty-five men daily, was started the 1st of September and continued until the latter part of December.

The principal obstructions being nine mill-dams, and there being no explicit authority for their removal or modification, operations were confined to the removal of bowlders, snags, and other work of such nature as to benefit the limited amount of navigation that could get over the dams between Pineville, or Cumberland Ford, and Finley's Bend.

The following work was accomplished:

Rock excavation	cubic yards	2,414
Loose and gravel excavation	do	465
Snags and overhanging trees removed	number	759

It is proper here to report that the State of Kentucky has during the last session of the legislature chartered a company to build locks and dams on this part of the Cumberland, with power to condemn mills, dams, and other real estate, and to collect tolls for the navigation of said river for fifty years. The act also provides that the company may begin operations at any time within three years, and before doing so they must pay to the county courts of Whitley, Knox, and Bell counties the sum of $2,666 each, "which amount has been expended in clearing out the obstructions and improving the navigation in said counties."

In view of these facts, I would respectfully recommend that no further appropriation be asked for this part of the river.

The Cumberland River is in the collection district of New Orleans. The nearest port of delivery is Nashville, Tenn.

Money statement.

July 1, 1881, amount available		$10,000 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$8,864 85	
July 1, 1882, outstanding liabilities	71 26	
		8,936 11
July 1, 1882, amount available		1,063 89
Amount appropriated by act passed August 2, 1882		5,000 00
Amount available for fiscal year ending June 30, 1883		6,063 89
Amount (estimated) required for completion of existing project		40,000 00

W 3.

IMPROVEMENT OF THE HIWASSEE RIVER, TENNESSEE.

Rising in the Blue Ridge Mountains, in Western North Carolina and Northern Georgia, the Hiwassee flows in a northwesterly direction into the State of Tennessee, where it becomes a navigable tributary to the Tennessee River. After breaking through the Smoky Mountain Range and receiving the waters of the Ocoee, near Charleston, the Hiwassee becomes a stream of good capacity for navigation, and as early as 1830 the State of Tennessee attempted some minor improvements with a view to utilizing it for that purpose.

The original project for the improvement by the General Government was based upon an examination made in 1874, and consisted in narrowing the water-way at the shoal places by wing-dams, and excavating rock reefs and gravel bars so as to secure a navigable channel, at extreme low-water, at least 2 feet deep and 40 feet wide.

These improvements have been carried on in former years from the mouth of the river to Brindley's Shoals, above Charleston, and 29½ miles from the mouth of the river. During the past year the improvement was extended to Gamble's Shoals, a few miles above the mouth of the Ocoee, and about 18 miles above Charleston.

Active operations were carried on by hired labor during July, August, and September, 1881, when the funds were exhausted. Assistant Engineer John S. Crary was in local charge of the work, with an average daily force of eighteen men. Work was done at Laster's Creek Shoals, Brindley's Shoals, Denton's Island, Boyd's Shoals, and, above the mouth of the Ocoee, at Horse Ford Shoals and Gamble's Shoals.

Seven hundred and eighty-eight cubic yards of bowlders were removed from the stream and used in building dams and protecting the banks;
Ten overhanging trees cut;
Thirty-two cords logs used in dams; and
Nineteen cubic yards rock-channel excavation.

The character of the work done has been to secure a practically permanent increase in the depth of the navigable channel, and but little expense will be required for such minor repairs as may become necessary in future. Boats drawing 22 inches passed safely, even on very low stages of the water.

The new appropriation will be applied in extending the improvem towards Savannah Ford, which will probably be the virtual head navigation under the existing project.

While the original estimate, if appropriated in two or three year would doubtless have completed all the work needed on this river, it probable that, owing to the small amounts annually appropriated, th balance of the original estimate will not do all that will be demand by those interested in the commerce of this stream; and the amount too small, in any event, to be economically expended. Some of the shoa already worked on can be still further improved to advantage, and Congress decides to continue the work to the extent of the original project, I would respectfully suggest that at least $5,000 be appropriat next year. If that is not done, it would be best to let the work remai as it is until a proper sum can be appropriated.

The commerce of this river is carried on by steamboats from the Tennessee Rive and by keel-boats above Charleston. By the middle of November, 1881, 120 bale cotton reached Charleston, from Polk County, 106 of which were forwarded by riv to Chattanooga. It is expected that at least 500 bales will be shipped from Po County during the coming season. Most of the traffic, however, is carried on in s an irregular way that it is impracticable to get reliable statistics in regard to it.

Hiwassee River is in the collection district of New Orleans. The nearest port delivery is Chattanooga, Tenn.

The original estimate of cost was	$20,000
Which has been increased	14,000
Making total estimate of cost of improving Hiwassee River Tennessee	34,000
Amount appropriated	29,000
Amount expended	27,46

Money statement.

July 1, 1881, amount available		$1,75
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$1,720 91	
July 1, 1882, outstanding liabilities	5 37	
		1,726
July 1, 1882, amount available		31
Amount appropriated by act passed August 2, 1882		1,500
Amount available for fiscal year ending June 30, 1883		1,531
Amount (estimated) required for completion of existing project		5,000
Amount that can be profitably expended in fiscal year ending June 30, 1884		5,000

W 4.

IMPROVEMENT OF FRENCH BROAD RIVER, TENNESSEE.

That portion of the French Broad River which lies within the Stat of Tennessee is 121 miles long, and from Leadvale to its mouth, 90 mil has a slope of only 1 foot per mile. It is also in other respects a fav able stream for navigation. Above Leadvale the river has a fall of feet in 74 miles, and is not, of course, susceptible of improvement, e cepting at an enormous cost.

The State of Tennessee made some attempts at improving this strea in 1836. In 1870 a limited survey of this section of the French Bro was made by Capt. M. B. Adams, United States Engineers, and an e amination of the same was made in 1875 from Henderson County line, North Carolina, to Leadvale, and in 1876 from the same point to the mouth of the river, upon which the present project of improvement was based. This project is to excavate solid rock, gravel, bowlders, and snags from the channel, to cut down overhanging trees, to build and repair the necessary wing-dams, so as to permit the passage of vessels drawing 2½ feet of water as high as Leadvale during the low water season.

Active operations were carried on by hired labor from July to the latter part of December, when work was suspended for the winter. In January the assistant engineer was employed in making detailed maps and plans of work when it should be resumed. At the end of the fiscal year the force had been reorganized and the plant put in good order for this season's work.

Assistant Engineer John S. Crary has been in local charge of the work with an average daily force of twenty-six men. Work was done at the following shoals, and has resulted in securing the additional low water depth set opposite the name of each obstruction:

Obstruction.	Gain.	Obstruction.	Gain.
	Inches.		*Inches.*
Fain's Island	14	Zimmerman's Island	23
Denton's Shoals	14	Hanging Rock Shoals	6
Bryant's Shoals	18	Saffil's Shoals	12
Evans's Shoals	23	Seven Islands	21

Twenty-five dams were built, containing 5,282 cubic yards of rock, of which 1,390 cubic yards were quarried, and the balance taken from the river bed. A number of bowlders and a small quantity of gravel and sand was removed from the channel, together with miscellaneous work in connection with the foregoing.

The appropriation ($5,000) made by act of August 2, 1882, and that asked for the next fiscal year ($15,000) can be profitably expended in removing rock, gravel bars, snags, &c., at the most troublesome obstructions, and in building light wing-dams at such points as will be of the greatest benefit to navigation, as provided for in the original plan of improvement.

During the four months ending July 1, 1882, 184 keel and flat boats came down the French Broad, laden with—

86,200	bushels of grain.
1,200,000	feet of lumber, &c.
179	tons of miscellaneous freight.

One hundred and twenty of these boats returned with 581 tons of freight. A steam tow-boat is building, to operate upon this river during the coming season.

This stream is in the collection district of New Orleans. The nearest port of delivery is Chattanooga.

From the Tennessee and North Carolina State line to Leadvale no estimate of cost of improvement was made, for reasons given by Major McFarland in 1876; neither was an estimate submitted for the 20 miles of river between Leadvale and Dandridge.

The original estimate of cost of improving French Broad River, from Dandridge to its mouth, was	$150,000 00
Amount appropriated	18,500 00
Amount expended	12,035 41

Money statement.

July 1, 1881, amount available		$8,839 88
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$6,854 26	
July 1, 1882, outstanding liabilities	521 03	
		7,375 29
July 1, 1881, amount available		1,464 59
Amount appropriated by act passed August 2, 1882		5,000 00
Amount available for fiscal year ending June 30, 1883		6,464 59
Amount (estimated) required for completion of existing project		130,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.		15,000 00

W 5.

IMPROVEMENT OF CLINCH RIVER, TENNESSEE.

The Clinch River enters the State of Tennessee from Virginia, and after a course of 230 miles flows into the Tennessee River at Kingston. It drains an area of about 1,400 square miles. At intervals from 1830 to 1844 the State of Tennessee appropriated money for the improvement of this river, the work done being principally the removal of logs and bowlders from the bed of the stream and the building of wing-dams to confine and deepen the stream and scour out the channel. Little permanent benefit resulted, and several of the dams have proved to be only obstructions.

The first examination of this river by the United States was made in 1875. Another examination was made in 1881, confined to that part of the river above Haynes, Union County.

The obstructions were found to be bowlders, gravel bars, ledges, old State wing-dams, mill-dams, fish-traps, snags, and overhanging trees.

The plan of improvement adopted is to remove the most dangerous obstructions down to extreme low water mark, blasting when necessary. Then to build wing-dams so as to secure, at ordinary low-water, a depth of 2 feet from Kingston to Clinton (70 miles) and of 1½ feet from Clinton to Haynes (75 miles).

Active operations continued during the year until December, when they were suspended on account of high-water. Mr. W. G. Sanborn was the assistant engineer in local charge, with an average force of thirteen men.

Work was done at various points from the Virginia State line to the mouth of the river. Some of the old State dams below Haynes were repaired. Two parties were at work most of the time. The worst obstructions were found at Black's Shoals, and this place has been essentially completed, as well as Sycamore and Hopson's Shoals above Hayne's.

During the year there have been excavated 1,309 cubic yards of solid rock, 1,247 cubic yards of loose rock; 1,686 cubic yards of dams have been built, 265 cubic yards of old dams taken away, and 586 snags and overhanging trees have been removed.

Numerous gauges have been established along the river, and the data thereby obtained will be of great assistance in the prosecution of the work as well as to those using the river for transportation.

The worst obstructions have been removed from the course of the river in Tennessee, and the channel is practically clear from Cox's Landing to Black's Shoals, a distance of 120 miles. Where work has been done passage is possible at a stage from 2 to 3 feet lower than ever before.

The present condition of the river is a gratifying return for the money expended, and those who make use of it are rapidly appreciating and utilizing the improvements.

The appropriation ($3,000) by act of August 2, 1882, and that asked for ($10,000) can be profitably applied to the continuation of the work of improving high-water navigation, by removing snags, bowlders, reefs, overhanging trees, and other channel obstructions, at such points in Tennessee as may be most advantageous to commerce.

Even late in the season half a dozen or more large rafts passed easily far below Black's Islands, and there is no trouble when the pilots follow the new channel. A few steamboats have plied occasionally on the Lower Clinch, but people along the river no longer wait for them. They are utilizing the improved channel and flat-boating is rapidly becoming popular. Saw-mills have nearly doubled in number during the past year, and their owners as well as the miners and others are now changing the forms of their boats so as better to adapt them to the improvements of the river.

It is estimated that during the year 25,000,000 feet of lumber have been rafted down, and about 4,000,000 feet of sawn lumber, in boats, most of the latter being black walnut. About two hundred and seventy-five other flat-boats have passed down, of which about fifty (a less number than usual from difficulty of hauling to boats) carried zinc ore. Of the rest, about half carried lumber, and the other half wheat, corn, potatoes, &c.

This river is in the collection district of New Orleans. The nearest port of delivery is Chattanooga, Tenn.

The original estimate for improving Clinch River, in Tennessee, was	$26,400 00
Amount appropriated	16,000 00
Amount expended	7,498 00

Money statement.

July 1, 1881, amount available		$9,247 00
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$3,664 75	
July 1, 1882, outstanding liabilities	80 25	
		3,745 00
July 1, 1882, amount available		5,502 00
Amount appropriated by act passed August 2, 1882		3,000 00
Amount available for fiscal year ending June 30, 1883		8,502 00
Amount (estimated) required for completion of existing project		10,400 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		10,400 00

W 6.

IMPROVEMENT OF DUCK RIVER, TENNESSEE.

Although the State of Tennessee never undertook to improve the navigation of the Duck River, it has three times, in 1840, 1844, and 1846, incorporated private companies whose intentions were to make the river navigable by means of locks and dams, if necessary, but the object sought was never attained by these means.

The first examination made by the United States was in October, 1879, and extended from the mouth 68 miles upstream to Centreville.

The obstructions were found to be the usual ones of snags, overhanging trees, sunken logs, reefs, and gravel bars.

The plan adopted was to remove the timber and rock obstructions, and to build wing-dams for the double purpose of deepening the water above and increasing the current so as to scour away the gravel below, the intention being to secure from 2½ to 3½ feet of water from four to six months in the year. This will answer all practicable purposes for several years.

Active operations were carried on for about seven months during the year by hired labor, under the charge of Assistant Engineer, J. E. Turtle, with an average daily force of thirteen men. Work was done at Swift Chute, Carter's Bend, Hackle Shoals, Log Shoals, Tracy Shoals, and Suck Island. One thousand and five snags and overhanging trees were cut out, 659 cubic yards of gravel were excavated from the channel, and 537 cubic yards of rock were quarried and placed in dams. Before the cessation of work in the winter all surface obstructions had been removed from Centreville to Carter's Bend, 2½ miles from the mouth of the river, and the work done had very much improved navigation and assisted raftsmen. It was reported that a larger number of rafts passed down the Duck River with fewer accidents and at a lower stage of water than ever before during the winter. Letters were received from raftsmen reporting the good condition of the new channel and the reduction of bad obstructions.

The number of rafts was about one hundred, averaging fifty logs each. Since the resumption of work this spring, the channel has been completed according to plan from Centreville to Five Islands Shoals, a distance of 29 miles.

It is proposed to expend this year's appropriation and that asked for next year in continuation of the plan adopted.

The improvement of this river will, when finished, be substantially permanent, the only damage of last winter being the loss of a few feet from the end of one of the dams necessarily left unfinished.

Duck River is in the collection district of New Orleans. The nearest port of delivery is Nashville, Tenn.

The original estimate of cost of improving Duck River was	$35,118 00
Amount appropriated	13,000 00
Amount expended	8,223 75

Money statement.

July 1, 1881, amount available		$7,200 82
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$4,574 25	
July 1, 1882, outstanding liabilities	850 32	
		5,424 57
July 1, 1882, amount available		1,776 25
Amount appropriated by act passed August 2, 1882		3,000 00
Amount available for fiscal year ending June 30, 1883		4,776 25
Amount (estimated) required for completion of existing project		22,118 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		10,000 00

W 7.

IMPROVEMENT OF OBEY'S RIVER, TENNESSEE.

This stream is a tributary of the Cumberland, which it enters at Celina, Tenn., about 3 miles south of the Kentucky line. The head of navigation is at Barnes' Landing, Tenn.

An examination was made in 1879, from Barnes' Landing to its mouth, a distance of about 43 miles.

The obstructions consist of gravel bars, loose rocks, rock reefs, snags, and overhanging trees, and at Hill's Landing of a crooked channel. The plan of improvement adopted consists in removing these obstructions and in building riprap dams, to facilitate especially the passage of rafts and high water navigation by steamboats of not over 3 feet draught, from the Cumberland, for four or five months in the year. No plan for navigation at extreme low-water has been considered, as the interests of commerce, now existing or likely to exist, do not appear to warrant any such extensive improvements.

In 1880 an appropriation of $4,000 was made for this stream, and work of removing the channel obstructions was begun in August, 1880. In 1881 an additional $2,500 was appropriated for this work. Active operations were in progress at the beginning of the fiscal year and were continued until the end of August, under the local direction of Assistant Engineer C. A. Turrell, with an average daily force of forty men, when the available funds were exhausted. About 26 miles of the lower river were worked over during the year, extending from Wolf Creek Bar to Shield's Ford, upon which stretch of river the following quantities of work were done:

Riprap dams built	cubic yards..	691
Gravel and loose rock excavated	do	2,644
Solid rock excavated	do	63
Snags, &c., removed		77

Raftsmen had great difficulty heretofore in getting their rafts through unbroken; but it has been reported that during the past season some sixty rafts passed into the Cumberland safely, and at a lower stage of water than usual.

The appropriation by act of August 2, 1882 ($5,000), can be best applied to continuing the work of reducing the gravel bars, removing the shallow rock reefs, snags, &c., from the channel, and this amount is deemed sufficient to complete the clearing of the channel to the extent needed by the limited commerce of this stream. No additional plan or estimate is therefore presented.

Obey's River is in collection district of New Orleans. Nashville is the nearest port of delivery.

The original estimate of cost of improving Obey's River, Tennessee, was..	$11,869 00
Amount appropriated	11,500 00
Amount expended	6,500 00

Money statement.

July 1, 1881, amount available		$3,375 22
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$3,303 12	
July 1, 1882, outstanding liabilities	72 10	
		3,375 22
Amount appropriated by act passed August 2, 1882		5,000 00

W 8.

IMPROVEMENT OF CANEY FORK RIVER, TENNESSEE.

This stream rises in the Cumberland Mountains, and enters the Cumberland River near Carthage, Tenn., at a point about 120 miles above Nashville. The head of navigation is generally considered to be at Sligo, Tenn., about 72 miles from its mouth, the fall being about 70 feet in that distance.

The State of Tennessee did some work upon this stream between the years 1830 and 1846, but little of value remains.

An examination was made in 1879 to the head of navigation, near Sligo Ford. The obstructions principally consist of gravel shoals, logs, snags, and overhanging trees, with rock reefs at a few points. The plan of improvement is simply to remove the channel obstructions and to build stone dams at certain points to facilitate the navigation at moderately high water for steamboats drawing not more than 3 feet for about five months in the year, which will enable boats to ply to and from the port of Nashville.

An appropriation ($10,000) was made in 1880, and work was begun in August of the same year. A further appropriation ($4,000) was made available in 1881. Active operations were in progress at the beginning of the fiscal year, and were continued until the funds were exhausted, at the end of August. The work was under the local direction of Assistant Engineer C. A. Turrell, with an average daily force of seventy-one men. During the fiscal year about 33 miles of the lower river were thoroughly worked over (the channel of the upper section being cleared during the early part of the season), extending from Table Rock Island to Perry's Bar, near its mouth. The following work was done:

Log and stone dams built	cubic yards..	2,5[illegible]
Trees girdled on caving banks	number..	7[illegible]
Overhanging trees cut	do....	564
Snags removed	do....	56[illegible]
Gravel and loose rock excavated	cubic yards..	2[illegible]

The appropriation ($4,000) made by act of August 2, 1882, and the amount for next fiscal year ($16,228) can be profitably applied to reducing gravel bars, rock ledges, and removing snags, &c., as contemplated in the original plan of improvement.

It is difficult to obtain any trustworthy figures as to the amount of commerce upon this stream, though it is claimed that considerable produce, especially tobacco, reaches a market at Nashville by way of the Caney Fork, general supplies being shipped for the up-stream trip.

This being a mountain stream, subject to caving banks and heavy floods and consequent drift, the work of clearing the channel can hardly be deemed permanent, but will require at intervals the removal of snags, drift, &c., at a small outlay.

Caney Fork River is in the collection district of New Orleans, and Nashville is the nearest port of delivery.

The amount estimated for improving Caney Fork River, Tennessee, was	$30,22[illegible]
Amount appropriated	14,000
Amount expended	10,000

Money statement.

July 1, 1881, amount available		$5,132 25
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$5,121 57	
July 1, 1882, outstanding liabilities	10 68	
		5,132 25
Amount appropriated by act passed August 2, 1882		4,000 00
Amount (estimated) required for completion of existing project		16,228 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		16,300 00

W 9.

IMPROVEMENT OF COOSA RIVER, GEORGIA AND ALABAMA.

The connection of the Tennessee River with the Gulf of Mexico by means of the Coosa River was at one time a subject under serious consideration, and as early as 1823 the State of Alabama appropriated money for this purpose, which act was approved by Congress in 1824, and four years later Congress appropriated a part of the Tennessee surplus for improving the Coosa.

In 1870 an examination of the Coosa River was authorized, from the Selma, Rome and Dalton Railroad Bridge up stream 77 miles to Greensport, and two years later an instrumental survey was made on which to base plans and estimates for improvement. In 1875 an examination was made from Rome down to Gadsden, about 135 miles, which resulted in a plan for improving the river so as to give a navigable channel 80 feet wide and 4 feet deep at extreme low-water. In 1876 an appropriation was made for improving the Coosa River between Rome and the Selma, Rome and Dalton Railroad Bridge, and from this time works of improvement have been going on. The Coosa, though crooked, is very favorable for improvement. The bed and banks are generally of permanent nature and the mean depth of water is great when compared with the width.

The obstructions consist mainly of gravel bars, rock reefs, and bowlders.

The projected improvement contemplates a channel at least 3 feet deep at extreme low-water.

Between Rome and Greensport the channel has been put in tolerably good condition, and work on that section has been suspended for the time being. Just below Greensport is a very serious obstruction in the shape of very broad and shallow reefs extending over about 5 miles. The fall of water here is 24 feet, and the greater part of the fall is within a length of 2 miles. These reefs are called Whistenant's and Ten Islands shoals. It has been found necessary to improve these shoals by an extended work, consisting of—

1st. A longitudinal dam 2,000 feet long, forming a canal, with a lock at the lower end.

2d. A dam 1,100 feet long, across the river, terminated at one bank by another lock.

3d. The utilization of a natural chute as part of the canal, placing a dam and third lock at its lower end.

It is upon these works that operations have been continued during the year by hired labor, averaging daily one hundred and twenty-one men, under local charge of Assistant Engineer M. T. Singleton. The following are the exact amounts of work done:

Masonry laid, cut stone and rubble	cubic yards	3,1
Dimension stone cut	do	6
Stone quarried for locks and dams	do	9,1
Stone placed in dams and riprap	do	14,3
Earth and gravel placed in dams and embankment	do	10,
Rock excavated from channel and lock-pit	do	7
Earth stripped from quarries, &c	do	3,3
Cribbing in dams, 16 feet base and 4 feet high	linear feet	7

Besides miscellaneous work connected with the foregoing.

The condition of the improvement on the 1st day of July, 1882, wa as follows:

Lock No. 1.—Masonry completed ready for the gates, and the longit dinal dam completed, excepting the short spur-dam connecting it wit the lock. This dam, although in a condition to be used at the beginni of the year, has been greatly strengthened and tightened by embankin earth, gravel, and rock against it; 500 cubic yards of additional e bankment will entirely complete this work.

Lock No. 2.—Masonry complete except setting the coping, which is a cut and can be set in a few days. The dam, 1,100 feet long, across th river at this lock is well advanced, the water above it standing with 1 foot of its ultimate level. The dams connecting the lower end of th lock with Wood's Island are also nearly completed.

Lock No. 3.—The stone is all cut with the exception of about 250 cub yards. The coffer-dam is completed and everything ready for layin masonry rapidly as soon as the land title has been perfected.

During the fall months, which embrace the period of extreme lo water, the work was seriously retarded by the prevalence of malari fevers, generally of a malignant typhoid type. During that time a average of over 20 per cent. of the force employed was constantly on th sick list. Aside from sickness and the usual winter freshets, nothin occurred during the year to materially interfere with the progress o the work.

During May and June a detailed survey, upon which plans and est mates can be based, was made of the river below Lock No. 3 to Broke Arrow Shoals, about 24 miles, in order that the work upon this part o the river may be finished at the same time as the locks and canal, so a then to open the river at once from Rome to the coal region of Sain Clair County.

The new appropriation and that herein asked for should be applied to the completion of the locks and other work at Ten Islands Shoals; t the further improvement of some of the most troublesome shoals be tween Rome and Greensport, which have been partially improved; an in extending the improvement below Ten Islands Shoals towards th Selma, Rome and Dalton Railroad Bridge.

J. M. Elliott, jr., general manager of Gadsden and Red Line steamer kindly furnished me with the following information in reference to th commerce and navigation of the Coosa River:

> Six steamers were employed on the river during the year, including two steam-tug These tugs tow from 6,000,000 to 7,000,000 feet of pine logs to the mills at Gadsd annually.
>
> During the year 1881 the steamers on the river between Greensport and Rome tran ported 26,300 bales cotton, about 2,000 tons of pig iron, 2,000,000 feet of lumber, an 28,000 tons general merchandise. They also carried 4,200 passengers during th time.
>
> The counties adjacent to the river last season produced 60,000 bales of cotton, mo of which found way to the market other than by river, owing to the fact that th season when most of the produce is being marketed is at the time of extreme lo water, and the inability of the boats to do the work at that season of the year.
>
> Before the improvement of the river by the United States the steamers were on

able to carry about one-fourth of what they now do at low-water. Where steamers of 20 feet beam and 120 feet long could formerly go, now we have a steamer 30 feet beam and 160 feet long which can run on the lowest stage of water, having successfully carried 601 bales cotton on the lowest stage of water known.

By further work on the river between Greensport and Rome, I believe that the receipts would increase to 50,000 or 60,000 bales of cotton annually, and the other traffic in proportion.

There are five saw-mills, two blast-furnaces (one in process of construction), and three towns or small cities on this river.

This work is in the collection district of Mobile. The amount of revenue collected at the nearest port of entry is unknown to me.

The original estimate of cost of improving Coosa River was	$552,347 00
Amount appropriated	360,000 00
Transferred by act of August 2, 1882, from improvement of Etowah River.	8,700 00
Total amount appropriated	368,700 00
Amount expended	267,142 79

Money statement.

July 1, 1881, amount available		$78,901 59
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$53,831 98	
July 1, 1882, outstanding liabilities	7,212 40	
		61,044 38
July 1, 1882, amount available		17,857 21
Amount appropriated by act passed August 2, 1882		83,700 00
Amount available for fiscal year ending June 30, 1883		101,557 21
Amount (estimated) required for completion of existing project		183,647 00
Amount that can be profitably expended in fiscal year ending June 30, 1884		150,000 00

W 10.

IMPROVEMENT OF OOSTENAULA AND COOSAWATTEE RIVERS, GEORGIA.

These streams are in Northwestern Georgia. Examinations of them were made in 1872 and 1874, from Carter's Mill, on the Coosawattee, to the mouth of the Oostenaula, near Rome, Ga., a distance of about 105 miles.

The obstructions were found to consist of gravel bars, rock reefs, snags, and overhanging trees. The plan of improvement was to remove these obstructions and to build the necessary wing-dams, so as to obtain, as far as practicable, navigation during nine months of the year for light-draught boats. No work was done during the last fiscal year on the Coosawattee, a good channel being already secured.

Active operations were in progress during July and August on the Oostenaula at the several obstructions below Calhoun, Ga. B. H. King, overseer, was in local charge of the works, with an average daily force of ten men.

The following work was done, and the channel greatly improved thereby:

Solid rock excavated	cubic yards..	131
Loose rock and gravel excavated	do	366
Overhanging trees cut		2
Snags removed		26

There appears to be no commercial necessity for any further improvement of these streams than that provided for by the new appropriation, which can be expended in removing the abandoned bridge piers at

Rome, and in such other work on the Oostenaula as can be done with the limited amount of funds.

No further appropriation is therefore asked for at present.

The cost of improving both streams is estimated at	$28,288 5
Amount appropriated	26,000
Amount expended	24,858 1

Money statement.

July 1, 1881, amount available		$879 5
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$715 80	
July 1, 1882, outstanding liabilities	21 85	
		737 6
July 1, 1882, amount available		141
Amount appropriated by act passed August 2, 1882		1,000
Amount available for fiscal year ending June 30, 1883		1,141

W 11.

IMPROVEMENT OF ETOWAH RIVER, GEORGIA.

The survey reported in December, 1879, shows that nothing whatev can be done to make the Etowah navigable without recourse to a syste of locks and dams, at a cost of over $2,000,000 for 63 miles, or $31,74 per mile, with no prospect of corresponding advantages.

Congress having approved by act of August 2, 1882, of the recom mendation made in the last annual report "that the balance of the appro priation for the stream" be made "available for this improvement belo Rome, Ga.," the amount of $8,700 transferred by the act to the Coosa River will be expended in accordance with approved plan for the improve ment of navigation below Rome, Ga., and the balance of $62.30 will b applied to the contingencies connected therewith.

Amount appropriated (act of August 14, 1876)	$10,000
Amount expended	1,237
Amount transferred (act of August 2, 1882)	8,700

Money statement.

July 1, 1881, amount available	$8,762
July 1, 1882, amount available	8,762
Amount transferred by act passed August 2, 1882, to Coosa River	8,700
Amount available for fiscal year ending June 30, 1883	62

W 12.

IMPROVEMENT OF OCMULGEE RIVER, GEORGIA.

The State of Georgia appropriated at various times for the improve ment of this stream, during the first forty years of this century, sum which amounted to not less than $60,000. The Ocmulgee, uniting wi the Oconee about 10 miles below Lumber City, forms the Altamaha, these three rivers being the water highways of the State.

The first notice taken of this river by the United States was in 1852, when an examination and survey were ordered. In 1875 an examination was made from Macon to the mouth of the river.

The obstructions are snags, sunken rafts, and logs, on which bars often form, overhanging trees, and occasional reefs. The banks are far from permanent in character, and the current is rapid.

There are many sharp bends in the river, and these are the wrecking places of rafts.

The remedy for these places is either to clear off the timber and allow the river to cut across the bend, or to build cribs or booms in the stream, so as to prevent rafts from leaving the channel.

Operations have continued by hired labor during the fiscal year, the last two months excepted. The assistant engineer in local charge was Mr. C. A. Locke, and for about three months Mr. A. L. Dearing (both under direction of Assistant Engineer B. W. Frobel), with an average daily force of eight men.

The new appropriation and that herein estimated for can be profitably applied to the continuation of operations with the snag-boat, in removing the most troublesome obstructions, and at some points in building cribs and booms, to prevent rafts from being drawn out of the channel and wrecked at the "breakovers."

As stated in former reports, the nature of the obstructions is such that there is no relation between the work originally estimated for and that required to be done in order to secure good navigation. This is partly due to the fact that the nature and number of the obstructions were not fully ascertained when the examination was made, and partly because the snags and resulting bars are constantly receiving accessions to their number; and as the appropriations have been distributed over some six years, it is not only probable that the original estimate will not complete all that requires to be done, but in the absence of a detailed survey of recent date it is impossible to say how much of an additional sum will be required. I am satisfied, however, that not less than $25,000 will be needed.

During the year, nine hundred and twenty-one snags and overhanging trees have been removed and 1,689 cubic yards of earth excavated from the channel.

The following steamboats ply on the river, all drawing 5 feet when laden: Cumberland, Halcyon, Mary Fisher, and Ida. Messrs. Merritt and Coney, of Hawkinsville, kindly inform me that the first three have been running monthly the past season between that place and Savannah. They would generally start with from 50 to 100 bales of cotton and complete their load at landings below. Late in the season they carried a large quantity of flour, hay, corn, and meat for the saw-mills along the route. They also report that turpentine stills are rapidly increasing in number, on account of the improved and more certain navigation. It is said that another and larger boat is to be put on the river during the fall of 1882.

Several letters were written weeks ago, inquiring for additional statistics of commerce, but no answers have yet been received.

This river is in the collection district of Brunswick, Ga., Darien being the nearest port of delivery. The amount of revenue is unknown to me.

The nearest permanent light-house structures are probably the beacons on Wolf's Island, near Darien, Ga.

The original estimate of cost of improving Ocmulgee River from Macon to its mouth was	$56,240 00
Increased in 1882	25,000 00
	81,240 00
Amount appropriated	54,000 00
Amount expended	48,799 49

Money statement.

July 1, 1881, amount available		$5,557
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$5,325 55	
July 1, 1882, outstanding liabilities	31 83	
		5,357
July 1, 1882, amount available		200
Amount appropriated by act passed August 2, 1882		5,000
Amount available for fiscal year ending June 30, 1883		5,200
Amount (estimated) required for completion of existing project		27,240
Amount that can be profitably expended in fiscal year ending June 30, 1884		10,000

W 13.

IMPROVEMENT OF OCONEE RIVER, GEORGIA.

In the first quarter of this century the State of Georgia appropriat sums on several occasions for the improvement of this river, the who amount thus appropriated being over $35,000.

The first examination by the United States was made in 1874.

The obstructions are snags, logs, bars formed by sunken logs, and few rock reefs, these obstructions interfering greatly with the commer of Dublin and vicinity, a town dependent entirely on river and wag transportation.

The great need of the river is such improvement as will make tran portation safe and practicable at lower stages of the water.

The improvement proposed is to clear the channel of these obstru tions and bars, getting 3 feet of water, and over if possible.

Active operations with the steam snag-boat were resumed by hir labor in the latter part of August, and continued until February, th latter part of this time being spent in overhauling the steam snag-boa Assistant Engineer C. A. Locke was in local charge, under direction Assistant Engineer B. W. Frobel; average daily force, seven men.

Work was done at some eighteen places above and below Dublin.

Four hundred and eighty-nine logs, snags, and overhanging trees were removed. Thirty cubic yards of rock were excavated from channel.

Many repairs to the snag-boat were necessary before work for th year began, and many had to be made as the work advanced, but th boat has been put in thorough repair for the next season.

The improvement of this river cannot be regarded as permanent, f it is changing its bed at many points, and an annual expenditure w always be necessary if the channel is to be kept clear.

The new appropriation and that herein asked for are to be expende in continuing the work of clearing the channel at Carr's Shoals an below Dublin.

Two or three steamers, drawing from 2 to 3 feet, ply this river between Dublin the Georgia Central Railroad, and below Dublin to the Altamaha River. Their goes consist of lumber, cotton, resin, turpentine, and provisions.

Commercial statistics for the year were written for several weeks ago, but h not been received in time for insertion.

This stream is in the collection district of Brunswick, Ga., Darien being the nea port of delivery.

The estimates for the work were	$50,0
Amount appropriated	20,5
Amount expended	15,

Money statement.

July 1, 1881, amount available	$2,851 78
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	2,813 93
July 1, 1882, amount available	37 85
Amount appropriated by act passed August 2, 1882	5,000 00
Amount available for fiscal year ending June 30, 1883	5,037 85
Amount (estimated) required for completion of existing project	29,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	10,000 00

W 14.

IMPROVEMENT OF RED RIVER, TENNESSEE.

As stated in last annual report on the improvement of this river—

> An examination of this stream from Port Royal to its mouth, a distance of 38 miles, was made in December, 1880, from which it was found that—
>
> "An expenditure of about $10,000 upon the 38 miles of river examined in removing snags, overhanging trees, loose rock and gravel, and in building a few stone dams would enable the smaller boats from the Cumberland River to ascend this stream at medium stages of the water, and with sufficient frequency to carry off the heavier products of the neighboring country."
>
> * * * * * * *
>
> There are three bridges across this stream, one for a railroad and the other two for turnpikes, the lowest being 41 and the highest 52 feet above low-water.
>
> Unless these bridges are provided with draws the high-water navigation of this stream will be greatly crippled, as steamboats will be unable to pass under these bridges, even with their chimneys lowered.

In 1881 an appropriation of $5,000 was made for this work, and in August of that year two working parties were organized, one working down stream from Port Royal, and the other working up stream from its mouth, under the direction of Assistant Engineer C. A. Turrell, with an average daily force of thirty-eight men.

Active operations were continued from August to the end of November, when the available funds were exhausted.

The 38 miles of river between Port Royal and its mouth have been much improved by the removal from the channel of—

1,458 cubic yards old fish-trap dams;
60 cubic yards solid rock;
1,463 cubic yards loose rock and gravel;
485 snags and logs;
1,664 overhanging trees cut; and about
1,050 cubic yards of riprap dams built.

Steamboats of not over 15 inches draught can navigate this river for about four months of the year. No plan has been submitted for low-water navigation, as the limited commerce would not warrant the heavy expenditures necessary.

No appropriation for this stream was made by act of August 2, 1882. Therefore no work can be done this season.

The appropriation asked for ($5,000), being balance of the original estimate, can be applied to clearing the channel of obstructions and building wing-dams, as proposed by the existing project.

This stream is in the collection district of New Orleans. Nearest port of delivery is Nashville, Tenn.

The estimate of cost of improving Red River, Tennessee, was	$10,103 00
Amount appropriated	5,000 00
Amount expended	4,956 43

Money statement.

July 1, 1881, amount available		$5
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$4, 862 75	
July 1, 1882, outstanding liabilities	93 68	
		4,
July 1, 1882, amount available		
Amount (estimated) required for completion of existing project		5
Amount that can be profitably expended in fiscal year ending June 30, 1884.		5

W 15.

EXAMINATION OF THE SOUTH FORK OF THE CUMBERLAND RI KENTUCKY.

An examination of this stream was made in 1881.

The obstructions were found to be reefs, bowlders, &c., being si in character to the other mountain streams tributary to the Cu land.

The plan adopted for the expenditure of the appropriation now a able and that herein asked for is to deepen the navigable channel f the Kentucky State line to the mouth of the river by excavation a narrowing the water-way by means of wing-dams, so as to secure a navigation upon rises above low water of not less than 3 feet.

The prospective commerce to be benefited by the proposed impr ment is the grain, lumber, and coal interests along the main str and its tributaries.

This stream, being tributary to the Cumberland, is in the collection district of Orleans. The nearest ports of delivery are Nashville and Chattanooga, Tenn.

The estimate of cost of improving this stream from the State line to its mouth was	$
Amount appropriated	3

This appropriation was made by act of August 2, 1882; therefor expenditures were made during the fiscal year.

Money statement.

Amount appropriated by act passed August 2, 1882	$3,
Amount (estimated) required for completion of existing project	59,
Amount that can be profitably expended in fiscal year ending June 30, 1884.	10,

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W 16.

SURVEY OF CUMBERLAND RIVER AT SMITH'S SHOALS, KENTUCKY. ASCERTAIN THE PRACTICABILITY AND THE COST OF A CANAL, WI LOCKS AND DAMS, FROM THE HEAD TO THE FOOT OF SAID SHOAL

UNITED STATES ENGINEER OFFICE,
Chattanooga, Tenn., February 15, 18

GENERAL: I have the honor to submit the following report on "Survey of Cumberland River, Kentucky, at Smith's Shoals," made compliance with act of Congress approved March 3, 1881, "to ascert the practicability and the cost of a canal, with locks and dams, from head to the foot of said shoals."

A survey of these shoals was made in 1875, and reported upon, Appendix R, Report of Chief of Engineers, 1875.

The present survey was limited to such measurements as were needed in making the estimates, and ascertaining the practicability of the work.

A strict construction of the act authorizing the survey calls for a "*canal* with locks and dams," but such a canal would be enormously expensive, if not impracticable, and would be entirely unnecessary, since the locks and dams would give sufficient depth to the river itself.

The river bed is in a gorge from 300 to 500 feet deep, which leaves no room for a canal, and at the same time renders it unnecessary, since it is possible to raise the water-level by means of dams to any desired height without overflowing the surrounding country. The estimate has therefore been made for *locks* and *dams*, using the *river itself* as a canal.

The language of the act also limits the survey to "Smith's Shoals," but as the principal object of the proposed improvement appears to be to enable coal miners in the vicinity of Rock Castle River to boat their coal to Nashville, it is evident that the river from the present head of navigation at Point Burnside to the mouth of Rock Castle River should be put in as good navigable condition as Smith's Shoals proper, in order that the improvement may fully accomplish its object. I will therefore add an estimate of the cost of extending the improvement as suggested.

There is no doubt as to the practicability of building the locks and dams so as to give any desired depth of water at all points on Smith's Shoals. The best way to do this would be to build a dam 38 feet high at the head of Mill Shoal, and four locks of about 16 feet lift each, connecting the level above the dam with the water at the foot of the shoals. The dam would be 850 feet long on the crest, and would back the water above the head of the Shadowen Shoal, which forms the upper member of the Smith's Shoals chain of obstructions. The locks would allow for a rise of 10 feet on the crest of the dam, which would correspond with a rise of 50 or 60 feet at the foot of the shoals, and there should be guard-gates at the upper lock several feet higher, so that even with a flood of 74 feet, the highest known at Point Burnside, the locks would be safe from overflow. This precaution would be necessary to protect the locks from damage, as well as to prevent logs and other drift from filling, and thus disabling them at the time when most needed.

Some doubt is expressed by Mr. Crozer, the assistant engineer who made the survey, as to the sufficiency of the foundation for a dam at Mill Shoal, but as the bed of the river consists of a tolerably solid rock, with an unlimited supply of building materials in the immediate vicinity, there can be no insurmountable difficulty in that respect.

In addition to being cheaper and more easily operated, the single dam and flight of locks would have the advantage over a number of detached ones in being more easily kept above the reach of floods, as already mentioned. No matter how low a dam might be, the lock would either have to be carried above high-water mark or it would be disabled during the high-water stages, when it would be most needed, and it might be necessary to wait for low-water before it could be cleaned out or repaired.

It will be noticed that Assistant Engineer Crozer estimates for six dams, each 20 feet high, with one lock at each dam, to make slackwater from Point Burnside to Rock Castle River; but as the Cumberland River floods rise from 40 to 74 feet at the points where his dams are located, it is evident that such an arrangment would not be available excepting at moderate stages on the river.

The use of timber in a work of this kind should be limited to those parts that will be absolutely protected from the air by being covered with water at all times, as the most durable timber decays very rapidly in this climate when exposed to the weather.

The dam at the head of Mill Shoal could probably be built of substantial masonry for	$240,000
And four locks, of 16 feet lift, and 55 by 140 feet in the chamber, at $80,000 each, would cost	320,000
Total	560,000

This is the estimate for improving the river "from the head to the foot of Smith's Shoals," but in order to make this improvement available it would be necessary to build—

An additional dam about 25 feet high, and three more locks, at or near Shadowen Shoal, the cost of which dam would be	$75,000
And that of the three locks, at $80,000	240,000
Making	315,000
Which added to the foregoing estimate	560,000
Makes a total of	875,000

as the cost of the entire improvement.

This estimate includes engineering and contingencies, but, viewed as a commercial enterprise, it should be increased by the probable annual cost of operating the locks and of minor repairs, capitalized at a fair rate of interest.

Ten dollars per diem, or about $3,600 per annum, would probably be the least sum that would cover these expenses, and this sum capitalized at 4 per cent. would amount to $90,000, which, added to the cost of the work estimated for, would give $965,000 as the entire outlay.

The advantages of this plan of improvement would be:

1. It would give absolutely safe and reliable navigation for rafts and coal-boats at all seasons of the year and all stages of the water from Rock Castle River to the present head of navigation at Point Burnside.

2. It would allow steamboats to ascend as well as provide for descending navigation.

3. The improvement would be permanent.

On the other hand it should be stated:

1. That even if Congress should make liberal appropriation for the work, say $300,000 for the first year, it would take at least four years to complete the work, during which time no advantage would result to navigation; while at the rate such appropriations are usually made, a much longer time would elapse before the improvement would become available.

2. That the present system of dams appears to give good satisfaction as far as tested, and it is probable that if the coal miners will make full use of the boating tides, and perhaps make some slight modifications in their temporary barges, they can now market all the coal they can mine, not only safely, but profitably.

3. So far as rafts and loose saw-logs are concerned, it is quite likely that the present arrangement is as good if not better than the locks and dams would be.

4. From the head of the Great Falls to the head of Smith's Shoals the Cumberland River falls 324 feet, and is so badly obstructed by

bowlders that it can never be made navigable for steamboats at any reasonable cost; it is not therefore probable that the improvement, even if completed as herein estimated for, would ever be extended to the Upper Cumberland.

In view of these considerations, I would respectfully recommend that the present system of dams be tried for at least one year longer before undertaking the more radical system of improvement; and if this recommendation is approved, a small additional sum could be advantageously expended in adding to and strengthening the dams already built, as suggested at the end of Assistant Engineer Crozer's report. If, however, Congress decides upon building the locks and dams, I would respectfully urge that at least one-fourth of the entire cost of the work be appropriated the first year, so that the necessary preparations can be made for a vigorous prosecution of the work.

The new work will not only be of no use, but will be liable to offer more or less obstruction to navigation until the entire work is completed.

Assistant Engineer Crozer's report and a map* of the Cumberland River from Point Burnside to the mouth of Rock Castle River are appended.

Very respectfully, your obedient servant,

W. R. KING,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. W. C. CROZER, ASSISTANT ENGINEER.

SOMERSET, KY., *February* 1, 1882.

MAJOR: I have the honor to submit the following report of the survey of Smith's Shoals, Cumberland River, made in compliance with your orders, with a view of inaugurating a system of slackwater by building of dams and locks.

Smith's Shoals have been a serious obstruction to the navigation of the river above the mouth of the South Fork, closing it entirely against up stream navigation, and rendering the down stream navigation both difficult and dangerous.

The only navigation has consisted in floating coal in flat-boats from the mines between Buck Creek and Rock Castle River, and rafts of saw-logs to Nashville and other points below.

Smith's Shoals are composed of four shoals separated by intervening pools of smooth water. The foot of the lower or Mill Shoals is 2.02 miles above the mouth of Big South Fork at Point Burnside, the head of steamboat navigation. Mill Shoal is 0.69 of a mile long, and has a fall of 16.7 feet.

The pool between this and Long Shoal is 0.68 of a mile in length, and has a fall of only 0.15 of a foot.

Long Shoal is 1.73 miles long, with a fall of 22.16 feet. Next comes a pool 0.42 of a mile long, with a fall of only 0.1 of a foot, reaching to the foot of White Cliff Riffle, which is 1.42 miles in length, with a fall of 4.19 feet. Another pool, 1 68 miles in length, having a fall of only 0.35 of a foot, extends to the foot of Shadowen Shoal, which is 1.79 miles long, and has a fall of 10.85 feet.

The total length of Smith's Shoals is 8.4 miles, and total fall 54.5 feet.

In the early days of shipping coal, sometimes 20 per cent. of the boats were lost in passing over the shoals. The points of danger were at what was called "The Breaker," near the foot of Long Shoal, and on Mill Shoal; here the waves were very rough, caused by a perpendicular fall of 2¼ feet over ledges of rock.

Some years ago the State of Kentucky made appropriations, which were expended in trying to improve the river at these two points, but as the work was injudiciously located, it was of no benefit. In 1874 Congress ordered a survey to be made of these shoals, which was done in 1875 by Mr. R. C. McCalla, under orders of Maj. W. McFarland. His report, contained in Report of Chief of Engineers for 1875, Appendix R, is referred to for more minute details of the shoals.

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* Map not printed.

As suggested by you, I made this survey with the view of building only one dam at the head of Mill Shoal of sufficient height to back the water over the entire shoal above and connecting with the pool at the foot of the shoals by several locks. After a careful examination, I think it doubtful whether a safe foundation for a dam of that height can be secured at a reasonable cost. The bed of the river here is composed of limestone in strata of from 8 to 18 inches, interstratified with soft blue shale which decomposes rapidly under the action of the water or upon exposure to the air.

If it should be decided to adopt a system of slackwater it would doubtless be better to build severeal dams of lesser height. The number of dams required will be determined by what portion of the river is to be so improved. Unless the system is to extend from Point Burnside to at least as high up as the mouth of Rock Castle River, I can see no benefit that is to be derived from it if confined to the shoal alone, for in the present condition of the shoals whenever a boat can reach there from above it can pass over in safety.

There are on an average twenty-four coal tides annually between Point Burnside and Nashville, while between Point Burnside and the mouth of Rock Castle the annual average is only three coal tides. Therefore, to construct a slackwater system that will be most beneficial to this portion of the river, I would suggest that one dam 20 feet high and 530 feet long be built at Point Burnside just above the mouth of Big South Fork, another 20 feet high and 800 feet long at the head of Mill Shoal, another 20 feet high and 800 feet long on Long Shoal just above the mouth of River Hollow, and another one 20 feet high and 650 feet long on White Cliff Riffle, 600 feet below the head of shoal. This dam will cover the entire shoal above and give 5 feet of water at Miller's mill. A dam just below this mill 20 feet high and 490 feet long, and another at the narrows 20 feet high and 410 feet long, will give 5 feet of water at mouth of Rock Castle River. These dams, if built of timber and filled with stone, as shown by the accompanying sketch, will cost $51.31 per linear foot. If built of stone, as per sketch, they will cost $64.80 per linear foot. While a stone dam of the dimensions shown on sketch is strong enough for ordinary streams, if it should be decided to adopt stone dams, I would recommend that the width be increased to 23 feet base and 8 feet at top, which would increase the cost to $80 per linear foot.

I think timber dams will be best adapted for this portion of the river, as they are not so liable to be injured by the immense amount of drift and saw-logs that pass here on every rise. These dams, if built of best quality of white oak, will last about twenty years, and ought to require no repairs for at least ten years.

For a timber dam 530 feet long, 20 feet high, with a base of 46 feet, the principal dimensions of longitudinal timbers of frame are 12 inches by 12 inches cross-section and 20, 25, 30, and 35 feet in length; all of such timber is calculated at the rate of 14 cents per linear foot. Sheeting for apron being 12 inches by 10 inches cross-section, and in uniform length of 15 feet.

Crown-sheeting being 12 inches by 2¼ inches cross-section, and in length of 16 feet 1¼ inches. Batten, running longitudinal with dam, one course on each of the aprons, are 12 inches by 6 inches cross-section, and in lengths of not less than 20 feet.

All such sheetings and battens are calculated at the rate of $16.50 per 1,000 feet, board measure.

IRON WORK OF DAM.

⅞-inch round iron drift bolts, 21 inches long, for main frame.

¾-inch square iron spikes, 18 inches long, flat, conical head, for sheeting of aprons.

7/16-inch square iron spikes, 6 inches long, for upper crown-sheeting.

⅝-inch square iron spikes, 12 inches long, for batten on aprons, to be about 2 feet apart.

Filling in dam, broken stone closely packed.

ESTIMATE OF MATERIAL AND COST OF TIMBER DAM.

Length of dam, 530 feet.
Width of base, 20 feet.
Difference in level of pool, 14 feet 6 inches.

QUANTITY AND COST OF TIMBER.

Longitudinal timber above water, 31,800 linear feet white oak, at 14 cents.	$4,452 00
Longitudinal timber below water, 10,600 linear feet white oak, at 13 cents.	1,378 00
Transverse timber above water, 19,746 linear feet white oak, at 14 cents...	2,764 44
Transverse timber below water, 8,480 linear feet white oak, at 13 cents....	1,102 40
Sheeting for apron, 159,000 feet, B. M., white oak, at $16.50..............	2,623 50
Sheeting for crown of dam, 42,930 feet, B. M., white oak, at $16.50........	708 34
Batten and apron, 6,360 feet, B. M., white oak, at $16.50..................	104 94
Total cost of timber...	13,133 62

QUANTITY AND COST OF IRON WORK.

For main frame, 6,447 drift bolts, ⅞-inch round iron, 21 inches long (weight per 100=368 pounds), 23,724 pounds, at 3 cents per pound	$711 72
For apron sheeting, 3,180 spikes, ¾-inch square iron, 18 inches long (weight per 100=258 pounds), 8,204 pounds, at 4 cents per pound	328 16
For battens, 530 spikes, ⅝-inch square iron, 12 inches long (weight per 100=132 pounds), 700 pounds, at 5 cents per pound	35 00
For crown-sheeting, 8,480 spikes, $\frac{7}{16}$ inch square iron, 6 inches long (weight per 100=33½ pounds), 2,840 pounds, at 6 cents per pound	170 40
Total cost of iron	1,245 28

FILLING.

279,450 cubic feet=10,350 cubic yards, broken stone=6,900 cubic yards (solid measure), at 50 cents per cubic yard	$3,450 00
Estimating labor of construction of dam in a ratio to cost of timber as 10 to 14, thus, $\frac{13,133.62}{14} \times 10$	9,381 15

RECAPITULATION.

Cost of timber	$13,133 62
Cost of iron	1,245 28
Cost of filling (stone)	3,450 00
Cost of labor	9,381 15
Total cost of dam	27,210 05

Stone dam, 530 feet long, 20 feet high; width at base, 15 feet, width at crown of dam, 5 feet.

Courses of stone being 24, 18, and 16 inches coping stone, to be not less than 2 feet thick, and additionally secured to the top of wall by suitable anchor bolts of 2-inch round iron and not less than 8 feet long, one anchor to each joint of coping.

Cross-section of dam, 189 square feet.
Weight of masonry (limestone), 165 pounds per cubic foot.
Weight of masonry per linear foot at dam, 31,185 pounds.
Difference of level of pools, 14 feet 6 inches.

Pressure against back of dam (20-foot depth)	12,500.00 lbs. per linear foot.
Pressure against front of dam (5-foot depth)	945.31 " " " "
Actual pressure against back of dam	11,554.69 lbs. (hydrostatic).

Coefficient of friction or stability of dam in this case, from the nature of its foundation, may safely be assumed (0.75), which will give us a resistance in friction of dam against the hydrostatic pressure of 31,185 × 0.75=23,388.75 pounds, hence a factor of safety of—

$$\frac{23,388.75}{11,554.69}=2.024.$$

The cross-section of dams being 189 square feet, and the length of wall being 5.30 feet, then we have 530×189 = 100,170 cubic feet = 3,710 cubic yards.

Of this we may estimate 3,000 cubic yards of cut stone (ashlar), the facing on back of dam only to be hammer-dressed. The remaining 710 cubic yards consists in scabbled stone, concrete and cement.

ESTIMATE OF MATERIAL AND COST OF STONE DAM.

Length of dam, 530 feet.
Height of dam, 20 feet.
Width of base, 15 feet.
Width of crown, 5 feet.
Difference in level of pool, 14 feet 6 inches.
Cross-section of dam, 189 square feet.
Cubic contents of cut stone, 3,000 cubic yards.
Cubic contents of scabbled stone, concrete and cement, 710 cubic yards.

3,000 cubic yards cut stone, laid, at $10.50	$31,500
710 cubic yards scabbled, &c	2,485
Cost of masonry	33,985
Anchor bolts:	
106 2-inch round iron anchor bolts, 8 feet long, 9,000 pounds, at 4 cents	360
Total cost of stone dam	34,345

RECAPITULATION.

Cost of cut stone, laid	$31,500
Backing, cement, &c	2,485
Total cost of masonry	33,985
Cost of iron work	360
Total cost of stone dam	34,345

A lock of 140 feet between miter sills and 55 feet width of chamber will admit two ordinary coal barges.

Estimating such a lock with a lift of 15 feet to cost $43,000 gives the following summary, viz:

Six timber dams, total linear feet 3,680, at $51.31 per linear foot	$188,820 80
Six locks, at $43,000 each	258,000 00
Total cost, if timber dams are adopted	446,820 80
Six stone dams, total linear feet 3,680, at $64.80 per linear foot	238,464 00
Six locks, at $43,000 each	258,000 00
Total cost, if light stone dams are adopted	496,464 00
Six stone dams, total linear feet 3,680, at $80 per linear foot	294,400 00
Six locks, at $43,000 each	258,000 00
Total cost, if heavier stone dams are adopted	552,400 00

I would respectfully suggest that an appropriation of $25,000 to complete the present unfinished dams on Mill and Long Shoals, and to build two dams on Shadowen Shoals, and an appropriation of $10,000 to be expended between the head of Smith's Shoals and the falls of the Cumberland, and an appropriation of $5,000 to be expended in Rock Castle River between the mouth and the narrows, would be more benefit to commerce than the locking and damming the shoals.

Respectfully,

W. C. CROZER,
Assistant Engineer.

Maj. W. R. KING,
Corps of Engineers, U. S. A.

W 17.

EXAMINATION OF THE LITTLE TENNESSEE RIVER, TENNESSEE.

This river rises in the Blue Ridge and enters the Tennessee River near Lenoirs, Tenn.

Three examinations of this stream have been made. In 1874, from its mouth to the Chilhowee Mountains, an estimated distance of 25 miles. In 1875, from the mouth of Citico Creek (Mountains) to Rabun Gap, Georgia, a distance of about 109 miles. In 1882 from its mouth to the mouth of the Tellico River, about 13 miles.

The obstructions consist of snags, bowlders, reefs, &c., and the plan approved is to remove these obstructions, and to build stone wing-dams, to prolong the season of navigation, by securing a good channel, 40 feet wide and 2 feet deep, to the mouth of Tellico River.

The present appropriation and that herein asked for are to be applied as above stated.

No definite commercial data have as yet been obtained, though it is reported that large quantities of grain, &c., are boated down the stream to a market.

This stream, being tributary to the Tennessee, is in the collection district of New Orleans. The nearest port of delivery is Chattanooga, Tenn.

The estimate for improving this stream from its mouth to the mouth of Tellico River, upon which the present plan is based, was	$23,724
Amount appropriated	5,000

This appropriation was made by act of August 2, 1882; therefore no expenditures were made during the fiscal year.

Money statement.

Amount appropriated by act passed August 2, 1882	$5,000 00
Amount (estimated) required for completion of existing project	18,724 00
Amount that can be profitably expended in fiscal year ending June 30, 1884.	10,000 00

W 18.

EXAMINATION OF BEAR CREEK, RUNNING FROM NORTHEAST MISSISSIPPI INTO THE TENNESSEE RIVER.

UNITED STATES ENGINEER OFFICE,
Chattanooga, Tenn., January 26, 1882.

GENERAL: I have the honor to submit the following report on the examination of "Bear Creek, running from Northeast Mississippi into the Tennessee River," made in compliance with act of Congress approved March 3, 1881.

A survey of this creek was made in 1875, with a view to utilizing it in connecting the Tennessee and Tombigbee rivers by canal. (See Report of Chief of Engineers, 1875, page 27.)

With respect to the present examination, it appears that two commercial interests may be served by the improvement of this stream:

First. It may be used as an outlet for the lumber and other products of some 200 square miles of country in parts of Itawamba and Tishomingo counties, Mississippi, and of Franklin and Colbert counties, Alabama; and

Second. It may be used as a connecting link between the Lower Tennessee River and the Memphis and Charleston Railway.

For the latter purpose it would require to be improved only for a distance of about 18 miles; but the improvement would have to be such as to enable steamboats from the Tennessee to ascend as far as the railroad bridge, which would require locks and dams; while in the former case the improvement should extend at least 12 miles above the bridge, but the work required would be simply to remove snags, overhanging trees, &c., with a view to a downstream navigation by rafts and flat-boats.

As the fall between the Memphis and Charleston Railroad Bridge and the mouth of Bear Creek is some 21 feet, at least two locks would be required, and in the absence of any pressing demand for steam navigation, as suggested, it has been inferred that the less expensive plan of improvement would be sufficient.

The cost of removing the snags and fish-traps, closing certain cut-offs, and putting this stream in proper navigable condition for rafts and flat-boats has been estimated by Assistant Engineer J. H. Mayhew, who made the examination, at $5,900, and this amount would probably be sufficient for the purpose.

The population of Colbert and Tishomingo counties in 1880 was about 26,000; only a fraction of this number, however, would be materially benefited by the improvement.

The work, when completed in accordance with the plan proposed, would require a small expenditure from time to time to remove snags that may lodge in the channel during floods.

Report of Assistant Engineer James H. Mayhew, with sketch* of Big Bear Creek, is forwarded herewith.

Very respectfully, your obedient servant,

W. R. KING,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. JAMES H. MAYHEW, ASSISTANT ENGINEER.

MILTON'S BLUFF, *December* 23, 1881.

MAJOR: I have the honor to submit the following report upon the examination of Big Bear Creek, from the Memphis and Charleston Railroad Bridge to its mouth, at Eastport, on the Tennessee River.

This stream, which is some 40 miles long, has its source in Franklin County, Alabama, and after flowing through a part of Colbert County, Alabama, and Tishomingo County, Mississippi, empties into the Tennessee near Eastport.

The principal interest to by advanced by improving this stream is that in logs and lumber, the country around its head being heavily timbered, and having no available outlet to a market.

To meet this interest fully, the stream would need to be cleared of logs and snags above low-water mark for some 10 or 12 miles above the railroad bridge.

From all the information I could get, I would estimate that about 300,000 feet of logs are now carried out annually, even under the present difficulties in the way of descending with rafts; they are, however, only taken out on high floods, and then in small numbers at a time. The principal products of these counties are corn, cotton, and lumber. A small vein of coal has been found near the Memphis and Charleston Railroad Bridge, but has never been developed sufficiently to test its quality or quantity. The stream is a very crooked one, as is shown by the fact that the distance by water from the Memphis and Charleston Bridge to its mouth is nearly 18 miles, while by land it is only a little more than 9. The fall from the Memphis and Charleston Bridge to Eastport is fully 30 feet at low-water, the greatest fall occurring at the bends; this, with the narrowing of the channel consequent upon the accumulation at these points of drift and "towheads" overgrown with willows, will make it extremely difficult, if not impossible, for a boat to work up against the cross-currents caused by the very short bends, even were obstacles such as drift and snags removed.

The stream is subject to sudden rise and fall. The depth of water during the winter and spring is sufficient for boats drawing 2 feet. On December 15 and 16, with water 2 feet above low-water mark, I found only one point where the depth was less than 3 feet, and that was only for a short distance—about 100 feet. This point is marked in the accompanying sketch as obstruction No. 2. The greater part of stream, except at the obstructions and at the ferries and fish-traps, was over 4 feet in depth. The banks are generally low and composed of a sandy loam, easily washed out; sloughs, small swamps, and cut-offs are numerous, and the channel variable; deposits of soil and gravel, overgrown with willows, occur at every bend; overhanging trees, snags, logs, and drift are very frequent—in three instances obstructing the channel so much that a skiff can pass with difficulty; in one instance we were obliged to drag our boat over and under logs, drift, and fallen trees to clear water. The rapid fall, combined with the short, abrupt bends of the channel, constitute the chief difficulty of making this available for transportation, even at high-water. As the character of the stream precludes the idea of low or slack water navigation, except at an expense far beyond that warranted by the commerce to be benefited, I make no estimate upon that basis, as the present and future commerce of the stream, it is thought, will be fully served by such improvement as will facilitate the descent of flat-boats, timber-rafts, &c., during six or eight months of the year. The following estimate, made for opening this part of Big Bear Creek, is thought sufficient.

The clear stretches of good water, taken together, will amount to about 6 miles, which will require very little work save the removal of two fish-dams, at an expense of $50 each, leaving 12 miles of the stream to be improved. To remove overhanging trees, drift, and snags down to low-water mark will cost $200 per mile. In addition to this, there are three points where cut-offs must be closed and the water confined to the channel; these will require $300 each.

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* Sketch not printed.

Removing two fish-dams, at $50 each	$100
Removing trees, logs, snags, 12 miles, at $200	2,400
Closing three cut-offs, at $300 each	900
Snag-boat and outfit	2,000
Contingencies	500
Total	5,900

In addition to the above estimate for the labor necessary to remove these obstructions, there is an item of expense of considerable importance to be taken into consideration, and one which is not easily estimated for, namely, the difficulty likely to be encountered in working in a stream which is subject to sudden rise and fall, which has a very strong current, and which is not of sufficient capacity to allow the removal of the working-boat from point to point over the bars at low-water. This difficulty will increase the cost of this work from 30 to 50 per cent.

The character of this improvement will not be permanent, as it will be necessary at intervals, depending upon the winter floods, to repeat a part of this work, as there will be an accumulation of drift and snags after each high-water.

Very respectfully, your obedient servant,

JAMES H. MAYHEW,
Assistant Engineer.

Maj. W. R. KING.

W 19.

EXAMINATION OF LITTLE TENNESSEE RIVER FROM ITS MOUTH ON THE HOLSTON OR BIG TENNESSEE RIVER TO THE MOUTH OF TELLICO RIVER.

UNITED STATES ENGINEER OFFICE,
Chattanooga, Tenn., January 26, 1882.

GENERAL: I have the honor to submit the following report on the examination of "Little Tennessee River from its mouth on the Holston or Big Tennessee River to the mouth of Tellico River," made in compliance with act of Congress approved March 3, 1881.

An examination of this stream was made in 1875 from its mouth to the Chilhowee Mountains, and reported in Appendix R 9, Report of Chief of Engineers, 1875, to which reference is here made, especially in regard to the resources of the country drained by this river.

The present examination extended only to the mouth of the Tellico; but a few miles of the Tellico were examined, incidentally, as some of the principal interests navigating this stream, among which are the marble quarries, are located upon the Tellico, the principal tributary to the Little Tennessee.

These streams are now navigable by small steamers at medium and higher stages of the water, and the improvement needed is the removal of snags, bowlders, reefs, and other obstructions, and the building of stone wing-dams, so as to prolong the season of navigability of the stream as well as diminish the danger of navigation during high-water.

A detailed description of all the obstructions and estimates for their removal will be found in the appended report of Assistant Engineer J. H. Mayhew.

The Little Tennessee traverses a very rich agricultural and mineral country, which is now cut off from all other means of transportation excepting the very expensive one with wagons, and the amount estimated for the improvement of this stream, $23,724, will probably be sufficient to put it in good navigable condition.

The estimate for the Tellico, although not asked for by the act under which the examination was made, is appended to Mr. Mayhew's report for such action as may be thought proper.

There is also appended a map of that part of the river examined, and sketches of the principal obstructions.

The proposed improvements will be of a permanent nature.

Very respectfully, your obedient servant,

W. R. KING,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. JAMES H. MAYHEW, ASSISTANT ENGINEER.

CHATTANOOGA, *November* 2, 1881.

MAJOR: In accordance with instructions received from you October 13, I proceeded at once upon the examination of the Little Tennessee River from its mouth on the Holston or Big Tennessee to the mouth of the Tellico River, a detailed report of which I beg leave to submit.

In regard to the commerce and production of the valley of the Little Tennessee, I find that I can add nothing to the information already given in Mr. Kingsley's report, made in 1874.

I began my examination at Calloway's Ferry, which is 2¼ miles above the mouth of the Tellico and just below the Ta-Mot-ley Islands; from this point to the mouth of the Tellico River there are no obstructions to boats drawing 24 inches—only one rapid fall, one-fourth of a mile below Mrs. Calloway's, over which there is the required 2 feet in depth at low-water.

In stating the quantities to be removed at the various points I give an estimate based upon personal examination of the localities mentioned, together with the best information I could collect from those acquainted with the obstructions.

The prices given are such as are thought necessary for the removal of small quantities at points distant from each other, and for rock that is thought to be difficult to remove. The estimates here made are for a channel width of 40 feet and 2 feet in depth at lowest water.

Niles Shoals.—This is the first shoal water below the mouth of the Tellico; the river here flows over a gravel bar around an old fish-dam.

The channel above and below is near the center of the river, which at this point is nearly 500 feet wide, but turns to the left bank just above the old dam. This dam or fish-trap is partly bare at low water and extends nearly two-thirds of the distance across the river.

I find 2 feet of water over the bar at the present low stage, said to be as low as ever known, so that, with the exception of an amount sufficient to remove two snags lodged at the head of the fall, I make no estimate for its improvement. Removing two snags, at $5 each, $10.

Wild Cat Shoal.—This shoal is 1 mile farther down the river, and is a short fall of about 150 feet over a rock bed, with a few bowlders, and will require for its improvement 75 cubic yards of rock excavation, at $6 per yard, $450.

About 500 feet below this is what is known as *Creuse's old fish-dam;* consists of a short rapid fall over large gravel or bowlders, and will require 250 yards loose rock and gravel excavation, at $1, $250.

Some 600 yards below this is *Creuse's Shoal;* a short, rapid fall over and around a ledge of solid rock, which extends from the right bank obliquely down and across the stream toward a small towhead near the left bank. It will require the removal of about 75 cubic yards of this ledge to give an adequate channel. The amount of water running around this towhead is inconsiderable at a low stage, so that little would be gained by closing this chute. Estimate for Creuse's Shoal: 75 cubic yards rock excavation, at $6, $450.

At a point nearly half a mile above these last three mentioned is a chute around what is called Ross's Island. There are several towheads at the head of this island, which is low, and would make the closing of this difficult.

Three-fourths of a mile below Creuse's and just opposite *Ware's*, there is a short gravel bar, 60 feet long, which will require 50 cubic yards of gravel excavation, at $1, $50.

Shoals above Morgantown.—They are simply shallow water over broad gravel bars and with slight fall. They are about 600 feet long, and will require 500 cubic yards of gravel excavation, at $1, $500.

Shoals below Morgantown.—This obstruction is about half a mile below Morgantown, is 350 feet long, over solid rock and gravel, and requires 350 cubic yards gravel excavation, at $1, $350; 100 cubic yards solid rock excavation, at $6, $600.

Blenkenship Shoals, one mile below, are 400 feet long, over rock and gravel bed, with two ledges of rock jutting into the stream from the right bank. Their improvement will require 150 cubic yards of rock excavation, at $6, $900; 300 cubic yards gravel excavation, at $1, $300.

Half a mile above *Jackson's Ferry* is a large snag to be removed; probable cost, $10.

Carpenter's Island Shoals, situated near the head of an island of the same name, is caused by a reef of bowlders and rock which projects from the right bank of the stream, three-fourths of the distance across, and causes a very sharp angle in the channel, which is quite close to the left bank. The fall is rapid, estimated at 2 feet in 1,000. The chute around the island is said to be filling gradually. The depth in the channel opposite the ledge or bar is all that is needed; the improvement necessary is to straighten this part of the channel and deepen the bar just above. Estimate: 100 cubic yards rock excavation, at $6, $600; 250 cubic yards gravel excavation, at $1, $250.

Two miles and a half below this, and 6 miles from the mouth of the river, are what is known as *Bowman's or Upper Coytee Shoals*. They are half a mile long and are a succession of rock and gravel bars, while between the bars are short distances of fairly good water. The river at this point is about 600 feet wide; the plan thought best for improving this obstruction is to put in two or three low riprap wing-dams from the right bank out to the channel, which is less than 100 feet from the left bank. The fact that old fish-dams have remained intact for years in this river is evidence that these low dams, just sufficient to turn the water into the channel, will remain permanent. These, with the required excavation, will provide a good channel depth over these obstructions. Near the middle of this shoal, and just opposite the Coytee post-office, and on the left bank, is a ledge of solid rock projecting into the channel in 3 feet water. There are also several bowlders of solid rock just below this ledge that should be removed. Estimates for this shoal: 900 linear feet of riprap dam, at $3 per foot, $2,700; 250 yards solid rock excavation, at $6 per yard, $1,500; 1,000 cubic yards gravel excavation, at $1 per yard, $1,000.

A little more than a mile below this, at Davis Ford, is what is known as the *Davis Shoals*, where the channel changes to the right bank, passing between it and a ledge of rock located in the center of the river. To remove enough of this ledge together with several solid bowlders below it will require 100 cubic yards solid rock excavation, at $6, $600. The removal of the gravel bar above this will require 200 yards gravel excavation, at $1, $200. Half a mile below this is *Calloway's Rock*, a ledge directly in the channel, which, here, is quite close to the right shore and narrow; above and below are several bowlders. There are also two gravel bars, one above and the other below the fall, which is quite rapid, 1.4 feet in 850 feet. Will require 50 cubic yards rock excavation, at $6, $3,000; 400 cubic yards gravel excavation, at $1, $400.

Coytee Shoals.—This fall is for more than half a mile over alternating rock and gravel bars; is quite rapid, having a fall of 3.1 feet in 2,000 feet. The greatest fall is at the old fish-trap dam, between which and a ledge of solid rock on the left of the channel and near the left bank the water is confined, giving sufficient depth directly through the fall, while above and below the water spreads out over the bars and ledges.

The method suggested for improvement is similar to that proposed for the Upper Coytee, to excavate part of the channel and then increase the depth to the required amount by means of riprap dams. In this case, however, these dams should project from both banks toward the channel, which is near the center of the river. The exact best location for these dams can only be determined by a more careful survey. Three dams from each shore are proposed, which will require 1,500 linear feet of 3 feet riprap dam, at $3, $4,500; 500 cubic yards rock excavation, at $6, $3,000; 800 cubic yards gravel excavation, at $1, $800.

Just below this fall begins what is known as the Three-Mile Eddy, as the current is very slight from this point to the Tennessee River at Lenoirs. The only other obstructions are a few logs and snags in the *South Channel* around the island at Lenoirs; cost to remove these, $50.

The north channel around this island has been thought to be the best, but its character is certainly changing. There is a bar across the head of this channel over which, at the present low stage of water, even a skiff cannot pass only through a very narrow pass close to north bank.

The bar is nearly 200 feet long, and below it is a stretch for more than 600 feet of water, 20 to 24 inches, while the south channel is all good water save a bar 200 feet long just below the head of the island, over which there is now sufficient water.

The following is a statement of the *estimates* for improving the Little Tennessee River from its mouth, at Lenoirs, to the mouth of the Tellico River, based upon the adoption of a channel depth of 2 feet and 40 feet wide:

Niles Shoals, removing two snags, at $5 each..
Wild Cat Shoals, 75 cubic yards rock excavation, at $6 ....
Creuse's Old Dam, 250 cubic yards gravel excavation, at $1...................
Creuse's Shoal, 75 cubic yards rock excavation, at $6 ....
Ware's Bar, 50 cubic yards gravel excavation, at $1 ....
Shoals above Morgantown, 500 cubic yards gravel excavation, at $1 ....
Shoals below Morgantown:
  350 cubic yards gravel excavation, at $1..
  100 cubic yards rock excavation, at $6 ....
Blenkenship Shoals:
  150 cubic yards rock excavation, at $6 ....
  300 cubic yards gravel excavation, at $1..
Jackson's Ferry, removing one snag, at $10 ....
Carpenter's Island Shoal:
  100 cubic yards rock excavation, at $6 ....
  250 cubic yards gravel excavation, at $1 ....
Bowman's, or Upper Coytee:
  900 linear feet riprap dam, at $3...
  250 cubic yards rock excavation, at $6 ....
  1,000 cubic yards gravel excavation, at $1......................................
Davis Shoals:
  100 cubic yards rock excavation, at $6 ....
  200 cubic yards gravel excavation, at $1 ....
Calloway's Rock:
  50 cubic yards rock evcavation, at $6 ....
  400 cubic yards gravel excavation, at $1..
Coytee Shoals:
  1,500 linear feet riprap dam at $3..
  500 cubic yards rock excavation, at $6...
  800 cubic yards gravel excavation, at $1...
Removing trees and snags in south channel at Lenoirs ....

Adding 20 per cent. for contingencies, superintendence, &c.....................

Total ....

Very respectfully, your obedient servant,

JAMES H. MAYHEW,
Assistant Engi

Maj. W. R. KING,
Corps of Engineers, U. S. A.

TELLICO RIVER.

In addition to this report, I desire to mention some additional information in re to the Tellico River, which is an important factor in the commerce of the Little T nessee. This stream, which is from 80 to 130 feet broad, flows for more than 25 through the central portion of Monroe County, Tennessee, a county which ranks above the average in its production of cereals, which are its principal products.

According to the reports of 1880 it produced 566,000 bushels of corn, 114,000 bush wheat, and 80,000 bushels of oats, which places it among the first twenty-five count the State. During the winter months a large part of this grain from the eastern tion of the county is even now, with the river in its present condition, boated d The boats used are pole barges, 8 to 12 feet beam, and from 40 to 70 feet long, dra 8 to 18 inches.

Of the iron and timber interests, which are said to be of importance farther u valley, I make no report, that portion of the river not being embraced in any ex ination, and my facilities for obtaining information limited.

About 1 mile above what is known as Hawkin's Mill, which is 6 miles from mouth of the river, and the point from which I began the examination, is a larg posit of the variegated Tennessee marble, at present worked by Messrs. Reyn Huling. From December, 1880, to April, 1881, they shipped about 6,000 cubic f and there are three or four boat-loads now at their landing awaiting shipment. T firm have already done much in opening the Tellico as a channel for transporta At Hawkin's Mill they have built a rough lock which will carry their barges the 4-foot dam at that point. They have also cleaned the channel at several p of drift and loose bowlders. The Tellico is tortuous in its course, winding amo ridges which it crosses, with its valleys or bottom lands alternating first on one side and then the other, averaging from one-fourth to one mile wide. Higher up, I am told, the valleys grow broader and richer. Its banks are quite uniform in height along the valleys, averaging from 10 to 15 feet, while at the bluffs they are from 100 to 200 feet high. It has a fall estimated at 15 inches per mile; a 10-foot rise in the Little Tennessee having backed the water up 2 feet on the Hawkin's Mill dam. The fact that this dam, which is 4 feet high, gives a channel 2 feet deep for nearly 3 miles, shows how well suited this river is for slackwater navigation. The amount of water flowing at the lowest stage is too small to admit improvement by excavating a channel of the required depth through the long stretches of gravel bars. So I venture to suggest that the improvement first needed and which will be necessary, if slackwater navigation, by means of locks and dams, be determined upon, is the clearing out of rocks and ledges which now obstruct and are dangerous to boats descending at a stage 2 feet above low-water. The following is a detailed account of these obstructions for the first 6 miles, with an estimate of the cost of their removal:

(1.) *The Cow-ford Rock.*—This, including the bowlders just below it, is the first obstruction above the mouth of the river. It consists of two double ledges of solid rock, inclined about 45°; one ledge jutting out from the left bank, and the other from the right, changing the course of the channel very abruptly and making a very dangerous and narrow channel.

Eighty cubic yards of rock excavation will remove these sufficiently to open a good channel.

Just below these ledges, about 500 feet, are several large solid bowlders, or hog-backs, directly in the channel, and coming up to the surface at low-water; 12 cubic yards will include them; 80 cubic yards rock excavation, at $6, $480; 12 yards rock excavation, at $6, $72.

(2.) *Latimore's Ford.*—This is half a mile of shallow water, with a fall of a little more than 2 feet in that distance. The channel is obstructed by gravel bars and by loose, round bowlders from 6 to 18 inches in diameter. From the foot of this fall to the mouth of the river, 1¼ miles, there is no perceptible fall, and the depth of water is from 2 to 6 feet. Estimate: 400 cubic yards gravel excavation, at $1, $400.

(3.) Just above Mr. Blair's are three ledges of similar character to those at Cow-ford. These, with a few bowlders just below, will require 50 cubic yards of rock excavation, at $6, $300.

(4.) A quarter of a mile above this, at Richard White's, are three double ledges, which will require 100 cubic yards of rock excavation at $6, $600.

(5.) Between Richard White's and Hawkin's Mill there are three small rock ledges, which will require 10 cubic yards each, making 30 cubic yards rock excavation, at $6, $180.

(6.) *Shoal below Hawkin's Mill.*—This is half a mile, and should be cleared of logs, bowlders, and gravel bars. Estimate for this: 300 cubic yards gravel and loose rock excavation, at $1, $300.

Estimate for labor and material	$2,332 00
Add 20 per cent. for contingencies and superintendence	466 40
Total	2,798 40

Respectfully submitted.

JAMES H. MAYHEW,
Assistant Engineer.

Maj. W. R. KING,
Corps of Engineers, U. S. A.

W 20.

EXAMINATION OF CHATTAHOOCHEE RIVER, GEORGIA, BETWEEN WEST POINT AND BOLTON, ON THE WESTERN AND ATLANTIC RAILROAD.

UNITED STATES ENGINEER OFFICE,
Chattanooga, Tenn., February 25, 1882.

GENERAL: I have the honor to submit the following report on the examination of "the Chattahoochee River, in Georgia, between West Point and Bolton, on the Western and Atlantic Railroad, so as to complete the survey of that portion of the river," authorized by river and harbor act of March 3, 1881.

The survey referred to as requiring completion was reported in the Annual Report Chief of Engineers for 1880, page 1705 *et seq.* The object of the present examination was to ascertain whether any of the locks and dams estimated for in the former report could be dispensed with by excavating a channel through the reefs, and by employing wing-dams to regulate the width and depth of channel.

From a careful study of the data obtained from the former survey, it was found that the necessity for locks and dams was doubtful at only two of the shoals between West Point and Bolton, and at only one of these shoals locks had been estimated for.

Assistant Engineer J. H. Mayhew was accordingly sent to make further examination at these points, with instructions to make such surveys as would decide the question as to the necessity of locks and dams in the proposed improvement. The results of this resurvey indicate that at least one of the shoals in question will require locks and dams, so that the original estimate for this part of the river cannot safely be reduced. On the other hand, the rapid appreciation in the cost of labor and materials, if continued, may cause the work to cost more than the estimate.

The estimate was as follows:

SECTION II.—WESTERN AND ATLANTIC RAILROAD BRIDGE TO WEST POINT, GEORGIA, 108 MILES.

Channel excavation, 10,773 cubic yards, at $5	$53,865
Wing and riprap dams, 3,225 cubic yards, at $2.10	6,772
Timber for dams, 921,594 feet, board measure, at $15 per thousand	13,824
Stone in crib-dams, 13,121 cubic yards, at $1	13,121
Iron drift-bolts, &c., 6,213 pounds, at 6 cents	373
(These five items from Assistant Engineer Frobel's estimate.)	
Eight locks, 6 to 11 feet lift, averaging 10 feet lift, at an average cost of $39,680 each, including excavation, foundations, gates, wickets, &c	317,440
Add 20 per cent. for engineering and contingencies	81,079
	486,474

Very respectfully, your obedient servant,

W. R. KING,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX X.

IMPROVEMENT OF THE NAVIGATION AT THE FALLS OF OHIO RIVER—OPERATING AND MAINTAINING THE LOUISVILLE AND PORTLAND CANAL.

REPORT OF MAJOR G. WEITZEL, CORPS OF ENGINEERS, BVT. MAJ. GEN., U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Falls of the Ohio River.
2. Operating and maintaining the Louisville and Portland Canal.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., July 26, 1882.

GENERAL: I have the honor to transmit herewith the annual reports relating to the river and harbor improvements under my charge for the fiscal year ending June 30, 1882.

Very respectfully, your obedient servant,

G. WEITZEL,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

X 1.

IMPROVEMENT OF THE FALLS OF THE OHIO RIVER, INDIANA CHUTE.

We had an unusually good season last fall for this work. The river went down in August, 1881, so that work was begun on September 2, and with the exception of a slight interruption caused by a small rise during the latter part of that month, was continued until November 7. About 4,200 cubic yards of stone of the worst projecting reefs and rocks were drilled and blasted, and nearly all dumped into the deep water of the pool below.

A coffer-dam was built in the south side of the opening of the cross-dam in the Indiana Chute, for the purpose of making the extension of the southern portion of this cross-dam a moveable dam to the length of 160 feet.

The reasons for this are fully given in my special report dated Detroit, Mich., February 10, 1882, which is published in Senate Ex.-Doc. No. 129, Forty-seventh Congress, first session. I respectfully request that this report be republished in connection with this. The additional works which, in my opinion, are still necessary at this point to complete the improvement thereof in a manner to serve the interests of commerce are enumerated therein.

If Congress should make an appropriation to begin these additional works, they should be executed in the order which I give in that report.

The estimated cost of these additional works is $5,915,108.

The obstructions at this point were navigable during the past year an unusually large number of days, amounting to one hundred and twenty-seven days for descending boats only, and on one hundred and fifteen of these days being navigable for ascending boats. The usual annual average for both is about forty-five days.

Two thousand five hundred and forty-three vessels, with an undertonnage of 758,871 tons, passed over the falls. In addition to general merchandise, 18,545,000 bushels of coal, 18,600 tons of iron ore, and 1,955,000 feet of lumber passed over them.

The amount of money which was available for this work on July 1, 1881, was $71,760.73, of which $11,760.73 remained over from the appropriation for the improvement of the Falls of the Ohio which was made in 1875, and the $60,000 allotted from the appropriations for the improvement of the Ohio in 1880 and 1881 for the Indiana Chute. The whole of the former was expended on the coffer-dam above referred to and $22,357.87 of the latter. The balance available at the beginning of the present fiscal year was $37,642.13.

With this amount and that which may be appropriated by Congress at its present session, the work of removing the worst reefs and rocks in the Indiana Chute, and the work on the cross-dam suggested in my special report of February 10, 1882, should be continued, and if the amount of available funds is sufficiently large the construction of the extra set of gates in the branch above the new locks for high water lockage should be begun. Operations can be carried on simultaneously at these three points without the slightest interference with each other.

In order to carry on this work in an economical manner and at such a rate that it will interfere the least with the great and increasing commerce of the river, the sum of $1,000,000 should be appropriated for the fiscal year ending June 30, 1884.

The appended report of Mr. P. J. Schopp, assistant engineer in local charge of the work, will furnish further details.

The work is located in the third collection district of Kentucky. The nearest port of entry is Louisville, Ky.

The amount of revenue collected at this port during the fiscal year was $70,054.22.

The commerce and navigation of the Mississippi River and all its branches will be benefited by the completion of this work.

Money statement.

July 1, 1881, amount available	$71,760 73
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	34,118 60
July 1, 1882, amount available	37,642 13
Amount allotted from appropriation August 2, 1882, for improving Ohio River	35,000 00
Amount available for fiscal year ending June 30, 1883	72,642 13

REPORT OF MR. P. J. SCHOPP, ASSISTANT ENGINEER.

LOUISVILLE, KY., *July* 1, 1882.

SIR: I have the honor to submit herewith report upon improving Ohio River, Indiana Chute, during the fiscal year ending June 30, 1882.

For a number of years the stage of water has not been so favorable as in the last working season. The river being low work was commenced on the 2d of September, and, employing as many men as could be had, vigorously prosecuted until the close of the season, November 7.

The reefs above the railroad bridge being considered the most dangerous and the most difficult to work, were first attacked simultaneously on both sides of the navigable channel and also some projections in the middle of it.

Part of the left-hand reef was removed for a distance of 1,200 feet and the right-hand reef blasted for a distance of 1,300 feet and the rock removed for 700 feet.

Unfortunately the river commenced rising, and on the 24th of September work had to be suspended temporarily. The water during the rest of the season did not fall enough to remove all the rock blasted in that particular locality.

The result of our labor, however, was most beneficial. In the swiftest part of the Ohio Falls, where formerly existed a clear channel of only 45 feet, widened in the season of 1880 to 80 feet, a width of 200 feet is now secured by last season's work.

As the current proved too swift in places for the employment of the whole force above the bridge, the men were set to work on the right-hand reef below Rubel's rock reducing it in height, on Aleck's rock on the left taking off 2 feet, and on Wave rock on the right and left of the channel reducing it also in height.

During the two months of work in the Indiana Chute about 4,200 cubic yards of rock have been drilled and blasted, and, with the exception of a few hundred yards, deposited in the deep parts of the river.

At the end of the cross-dam, on the left of the Indiana Chute, a breakwater was constructed which may serve as a coffer-dam for the intended extension of the dam by a section of 160 feet of movable dam after the system of Boulé. The iron work as well as the timber foundations for this dam are now under construction.

The amount available on the 1st of July was	$71,760 73
Expended during the fiscal year 1881-1882	34,118 60
Available	37,642 13

Should the estimated amount of $70,000 to remove obstructions in the Indiana Chute be allowed for the next fiscal year, the estimated sum of $21,200 for the completion of the movable dam, Indiana Chute, would still be required for the fiscal year 1883-1884.

The measure introduced last year of keeping a record as accurate as could be obtained of all the vessels with their tonnage passing over the falls has been continued during the fiscal year just closed. The falls were navigable for ascending and descending boats one hundred and fifteen days; for descending boats only, one hundred and twenty-seven days. During this time there passed over the falls 2,543 vessels with an undertonnage of 758,871 tons; 18,545,000 bushels of coal, 18,600 tons of iron ore, 1,955,000 feet of lumber were transported over the falls.

A more detailed statement will be found in the annexed table.

Very respectfully, your obedient servant,

PHILIP J. SCHOPP,
Assistant Engineer.

Maj. G. WEITZEL,
Corps of Engineers, U. S. A.

Detailed statement of vessels passed over the Falls of the Ohio, number, undertonnage, amount, of coal, iron ore, &c., carried for the fiscal year ending June 30, 1882.

Date.	Descending boats.													
	Passenger boats.		Tow boats.		Model barges.		Square barges.		Government boats.	Rafts.	Lumber.	Coal, bushels.	Total.	
	Number.	Undertonnage.	Number.	Undertonnage.	Number.	Undertonnage.	Number.	Undertonnage.					Number.	Undertonnage.
1881.											*Feet.*			
July	6	2,856	7	399	..	......	11	1,034	..	..	....	....	24	4,289
August	....	....	....	......	..	......	....	....	..	..	....	....	....	....
September	....	....	....	......	..	......	....	....	..	..	....	....	....	....
October	....	....	....	......	..	......	......	....	..	..	....	....	....	....
November	12	7,094	2	141	..	......	9	1,758	..	..	....	75,000	23	8,993
December	36	15,270	31	5,385	6	1,822	189	60,336	..	..	....	3,049,500	262	82,831
1882.														
January	36	17,270	77	10,276	13	4,252	313	98,706	..	..	....	5,085,500	439	130,504
February	6	2,908	16	1,594	6	1,929	39	13,174	..	..	....	712,000	67	19,605
March	55	25,837	88	13,368	28	10,023	323	110,146	..	1	800,000	5,994,000	494	159,374
April	25	9,795	42	4,034	3	1,022	79	24,081	..	1	675,000	1,278,000	149	38,932
May	38	17,521	40	4,885	9	2,764	107	26,247	.	..	....	1,420,000	194	51,417
June	41	17,748	14	2,121	17	6,712	59	16,962	7	1	980,000	981,000	141	42,061
Total	255	116,299	317	42,203	82	28,525	1,129	352,464	7	3	1,955,000	18,545,000	1,793	337,906

Date.	Ascending boats.										
	Passenger boats.		Tow-boats.		Model barges.		Square barges.		Iron ore.	Total.	
	Number.	Undertonnage.	Number.	Undertonnage.	Number.	Undertonnage.	Number.	Undertonnage.		Number.	Undertonnage.
1881.									*Tons.*		
July	...	....	...	....	...	....	...	....	....	...	....
August	....	....	....	....	....	....	....	....	....	....	....
September	....	....	..	....	....	....	..	....	....	....	....
October	..	....	....	....	....	....	...	....	....	...	....
November	....	....	1	302	....	....	....	....	....	1	302
December	10	4,949	12	2,656	3	1,020	46	13,758	1,300	71	22,383
1882.											
January	31	14,867	28	5,051	13	3,691	95	28,144	4,600	167	51,753
February	5	2,464	14	1,246	....	....	43	11,308	....	62	15,018
March	37	19,143	55	7,358	15	4,877	96	32,887	5,100	203	64,265
April	7	3,127	25	4,006	7	2,417	52	13,736	2,500	91	23,286
May	16	7,575	27	3,610	2	786	66	18,329	1,200	111	30,300
June	15	6,904	12	1,712	6	2,836	11	2,706	3,900	44	13,658
Total	121	59,029	174	25,941	46	15,157	409	120,868	18,600	750	220,965

SPECIAL REPORT ON IMPROVEMENT OF THE FALLS OF THE OHIO RIVER.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., February 10, 1882.

GENERAL: I have received a letter from your office, of which the following is a copy, viz:

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 11, 1882.

SIR: The following copy of a resolution of the Senate of the United States is transmitted for your information and for report:

"IN THE SENATE OF THE UNITED STATES,
"*January* 9, 1882.

"*Resolved*, That the Secretary of War be directed to inform the Senate what, if any, additional works are necessary at the Falls of the Ohio River to complete the improvement thereof in a manner to serve the interests of the commerce of the Ohio River, and that he state the reasons why such additional works, if any, are necessary, and also submit an estimate of the same.

"Attest.

"F. E. SHOBER,
"*Acting Secretary.*"

By command of Brigadier-General Wright.

Very respectfully, your obedient servant,

JOHN G. PARKE,
Lieut. Col. of Engineers, Bvt. Maj. Gen., U. S. A.

Maj. G. WEITZEL,
Corps of Engineers.

In accordance with the directions contained therein, I have the honor to submit the following report, viz:

REPORT.

Before furnishing the information called for by the above resolution of the Senate of the United States, I deem it my duty to give a brief description of the obstructions known as the Falls of the Ohio, and a condensed history of the improvements which have been made on them up to the present time.

I. DESCRIPTION.

The obstructions to navigation in the Ohio River, known as the falls of the Ohio, are formed by an irregular mass of limestone lying in the bed of the river about 600 miles below its head, and about 366 above its mouth. The general direction of this mass of rock is from southwest to northeast. It is a natural dam, which produces a deep pool just above, the difference of level between the water surfaces in this and in the pool below being about 26 feet in low and about 18 inches in the highest stages.

In their natural condition these falls or rapids were impassable during the largest portion of the year, and at all other times, excepting when the river was very high, navigation over them was difficult and dangerous. When the river was high, the navigation was carried on in it without any difficulty.

There were three channels over these obstructions, known as the Indiana, Middle, and Kentucky chutes.

The former is the main and longest channel, and was the one most navigated. It runs near the Indiana shore, between it and Goose Island, and makes a large bend near the foot of the fall, called the Big Eddy. It was 4,659 yards, or about 2⅔ miles long. At extreme low stages, about one-half of its total fall, that is, 13 feet, occurred in the first 1,253 yards, or about seven-tenths of a mile, and about two-thirds of its fall, that is, 17½ feet, occurred in the first 1,986 yards, or about 1¼ miles. When the water rose 7 feet at the crest of the falls above extreme low-water, it rose about 18½ feet at the foot of the channel, and the difference of level between the water surfaces in the two pools was about 13½ feet. At this stage, the steamer Uncle Sam barely made the ascent on a trial. This steamer was owned by Mr. Paul Anderson. Her measured tonnage was 440; she drew 9½ feet of water, and was propelled by an engine of 250 horse-power.

The Middle chute begins about the middle of the river and passes down between Goose and Rock islands. The length of this channel is about 3,800 yards, or $2\frac{1}{6}$ miles long, and about 22 feet, or almost the entire fall is in the last 500 yards. All boats could ascend it when the water at the head rose about 13 feet. The rise in the pool below then amounted to about 29 feet, and the difference of level between the water surfaces of the two pools was then reduced to about 9 feet.

The Kentucky chute lies nearer to the Kentucky shore, and passes down between it and Rock Island. Its condition was similar to the Middle chute and it is navigable a little later than the Middie chute. Almost the entire fall is in the last 185 yards. The shortest line across this natural dam is via the Middle and Kentucky chutes, and is about 3,300 yards or $1\frac{11}{12}$ miles long.

The observations which were made and recorded established the fact that on an average the falls were not navigable ten and a half months per annum.

The fact that these obstructions were navigable at some stages and not at others arises from the circumstance (as indicated above) that when the river rises both pools rise, but not equally. The lower one rises by a greater amount in a given time than the upper one. A similar law exists as the river falls; that is, the lower pool falls more in a given time than the upper one.

II.—HISTORY.

I have recently come into the possession of a tracing of an engraving made for "Campbell's edition of Finlay's History of Kentucky, 1793." This engraving bears the title, "A plan of the Rapids of the Ohio." On it is indicated the location of a proposed canal around these obstructions, and there is a note which reads, "From A to B a canal is intended to be cut." The point A is placed just inside of the mouth of Beargrass Creek, and B just around the turn in the Kentucky shore below the present mills of the Louisville Cement Company. The canal is drawn running parallel to and but a short distance inside of the Kentucky shore line.

It seems, then, even at that early date the question of constructing a canal around these obstructions was agitated. I have not, however, been able to discover any records of such agitation earlier than 1802. Beginning in that year, various plans were from time to time suggested and attempted to be carried out, by individuals, associations, appeals to Congress, and incorporated companies, but without success.

The legislature of Kentucky being impressed with the importance of the subject, and finding the general government disinclined to prosecute the work, in 1825 granted a charter to a stock company, authorizing them to construct a canal around the Falls of the Ohio within the State of Kentucky. The act granting this charter was approved January 12, 1825, and fixed the time of completion of the canal at three years from that date. It becoming apparent that the company would not be able to complete the work in that time, the latter was extended by three subsequent acts to February 6, 1831.

The capital stock of the company was fixed at $600,000 by the original charter. This was enlarged by two subsequent acts, and finally fixed at $1,000,000. By the acts of Congress approved May 13, 1826, and March 2, 1829, the government became the owner of 2,335 of the 10,000 shares of stock in the company, for which it paid the par value, $233,500. Both of these acts of Congress provided that the Secretary of the Treasury should vote for president and directors of the company according to the number of shares owned by the government, and should receive upon this stock the proportion of the tolls which should, from time to time, be due to the United States for the shares aforesaid.

Thus, the government, for the first time in its history, I believe, became a stockholder in a private corporation chartered by a State, and that, too, in one whose object was to overcome obstructions to navigation in a national highway.

The company had great difficulties to encounter in raising money and otherwise, but the work was prosecuted with energy, and the canal was opened and the first boat passed through it on December 22, 1830, although many improvements on it were subsequently made. As originally constructed, it was 1.9 miles long, 64 feet wide, and had three combined lift locks at its lower end, each chamber having an available length of about 185 feet, and a length between miters of about 198 feet, a width of 50 feet, and a lift of about 8 feet 5¼ inches. The total cost of the work was $1,019,277.09. This includes the purchase of land.

When the canal was completed its dimensions were thought to be sufficient for all time, but in a little over twenty years (in 1852) only fifty-seven one-hundredths of the tonnage engaged in the Western rivers could pass through the locks.

In a few years after the canal was opened, many complaints were raised against it. It was urged as an objection that it was a monopoly granted to private individuals, in the construction and control of a work which was directly connected with, and, in effect, part of a great "national highway;" that the tolls levied were such as to impose a heavy tax on Western commerce, which ought not to be at the mercy of private corporations or individuals.

The total amount of tolls collected up to January 1, 1842, or in eleven years, was greater than the original cost of the work, as the following table will show:

Year.	Amount of tolls collected.
1831	$12,750 77
1832	25,756 12
1833	60,736 92
1834	61,848 17
1835	80,165 24
1836	88,343 23
1837	145,424 69
1838	121,107 16
1839	180,364 01
1840	134,904 55
1841	113,944 59
Total	1,025,345 45

At this time many of the stockholders had become of the opinion that, in order to quiet the public and unfetter commerce, the canal should be taken and held by the United States, be enlarged with all reasonable dispatch, and made free.

With the view to the accomplishment of this object, an act was passed by the legislature of Kentucky, which was approved January 21, 1842. This act amended the charter of the company, so that in lieu of declaring dividends the board of directors were authorized to purchase the stock held by private individuals with the net income, and that when these shares were all purchased to transfer the same to the United States on the condition that the government would only levy sufficient tolls to keep the same in repair and pay the necessary superintendence, custody, and expenses, and make all necessary improvements so as fully to answer the purpose of its establishment.

The stockholders met on July 4, 1842, and accepted this amended charter unanimously. Mr. John Hulme, superintendent of the canal, represented the stock owned by the United States under a power of attorney from the Secretary of the Treasury, and verbally accepted the same, although he did not have his vote entered of record, because he had received no instructions from the Secretary of the Treasury, although he had given the latter due notice of the time and object of the meeting.

After December 31, 1842, the company, in pursuance of the provisions of this amended charter, discontinued all further dividends and proceeded to appropriate the net proceeds of the canal to the purchase of the private stock.

Up to this date the aggregate amount of tolls collected was $1,120,350.55. The aggregate amount of cash dividends paid out was $822,539.

Year.	Cash dividends pai
1834	$50,19[illegible]
1835	54,[illegible]
1836	56,9[illegible]
1837	106,[illegible]
1838	124,2[illegible]
1839	135,9[illegible]
1840	80,43[illegible]
1841	125,4[illegible]
1842	78,3[illegible]
Total	822,539

Of this amount the government received $257,778, and in addition five hundred and sixty-seven shares of stock in lieu of dividends. On January 1, 1843, the government was the owner of two thousand nine hundred and two shares of stock, whose par value was $290,200. It had, therefore, a benefit in twelve years of $314,478 on its original investment of $233,500. In pursuance of the provisions of the amended charter of January 21, 1842, all the private stock except five shares were purchased during the next twelve years. The five shares were held by the president and directors under instructions from the Secretary of the Treasury, in order to preserve the legal organization of the company. The following table shows how and when this private stock was purchased:

Year.	Number of shares purchased.	Total amount paid.	Average price per share.
1843	471	$70,145	$14[illegible]
1844	544	86,496	159
1845	771	129,528	[illegible]
1846	665	117,705	17[illegible]
1847	667	124,062	18[illegible]
1848	526	102,570	19[illegible]
1849	634	129,336	[illegible]
1850	470	100,110	213
1851	400	88,800	222
1852	610	140,910	231
1853	530	127,200	[illegible]
1854	805	202,200	251
Total	7,093	1,419,062	....

From this table it seems that the price per share was originally fixed at $150, and that 9 per cent. interest was added for each year until purchased. There is an error, probably of print, in the document from which I have taken the table. The number of shares of private stock purchased was 7,093 and the cost was $1,419,062.

At this time the stock stood as follows: Held by directors individually, five shares; held by directors in trust for the United States, seven thousand and ninety-three shares; held by the United States, two thousand nine hundred and two shares; total, ten thousand shares.

The United States had, therefore, without expense, acquired nine thousand nine hundred and ninety-five shares of stock, and in consequence of the refusal by Congress at this time to accept the canal, its management remained in the hands of the five directors of the company.

In furtherance of the object declared by the act of January 21, 1842, the legislature of Kentucky, in 1844, passed an act that in the event of the United States becoming the sole owner of the canal the jurisdiction of the State over the canal should be yielded up to the Government of the United States. This act was approved February 22, 1844.

By the purchase of the private stock the canal in 1855 was placed in a condition and ready to be surrendered to the United States. But as she had failed, and even shown disinclination to take the canal and execute the trust declared by the act of 1842, the legislature of Kentucky, deeming it the best if not the only practicable course that could be adopted to carry into effect the provisions of that act, passed another act, which was approved December 19, 1857. This act so amended the charter of the company as to authorize it to construct a branch canal and enlarge the old one, with the revenues and on the credit of the corporation, sufficient to pass the largest class of vessels navigating the Ohio River. The object of this measure was to enlarge the canal and to present it to the public, free of tolls, at an early period.

On June 21, 1859, a meeting of merchants, steamboat masters and owners, was held in Cincinnati, "to consider the proposed improvements at the falls, and to adopt measures to bring the subject before Congress at its next session."

A committee was appointed which, together with another committee from Madison, Ind., went to Louisville, and there both were joined by a committee on the part of the citizens of that city. The Cincinnati committee consisted of Messrs. W. Hooper, Lewis Whiteman, Edmund Dexter, W. W. Scarborough, Richard Smith, Samuel Davis, jr., William Glenn, Thomas Sherlock, and John Williamson; the Louisville committee, of Messrs. H. D. Newcomb, A. L. Shotwell, Thomas H. Hunt, John Shallcross, Will. Watkins, Benjamin J. Adams, and D. S. Benedict.

It would be impossible to find anywhere sixteen laymen who were better qualified to give an opinion on the subject submitted to them, nor could anywhere a same number of gentlemen be found whose character and standing entitled their views to greater respect and confidence.

They were unanimously of the opinion, after having investigated the subject thoroughly, that the most desirable immediate improvement of the Falls of the Ohio was to enlarge the old canal with turnouts to admit of boats passing each other, and with a branch extending to below the foot of Sand Island.

In their report the following statements were italicized:

> Our commerce has built and paid for this canal which the government now owns and assumes to control.
>
> As matters now stand the Government of the United States is the *great impracticable* in the way of the improvement of the Ohio River; virtually it is the obstruction at the falls, and not the rocks in the river's bed. These would crumble at the touch of private enterprise. Grasping its stock in the present canal, the government issues its injunction against even the employment of its revenues in its amelioration.

The Secretary of the Treasury had forbidden the directors to apply the revenues of the canal to its improvement.

Then, by the act of May 24, 1860, Congress ratified the authority granted by the act of the Kentucky legislature with the proviso that the president and directors of the company should in no way use or pledge the faith or credit of the United States, and that when the enlargement was completed and paid for no more tolls should be collected than an amount sufficient to keep the canal in repair and pay necessary expenses of superintendence and management.

In the mean time the government had ordered three surveys of the Falls of the Ohio. These were made in 1843, 1845, and 1853, by Captain Cram, Corps of Topographical Engineers; Lieutenant-Colonel Long, Corps of Topographical Engineers, and a Board composed of Lieutenant-Colonel Long and Col. William Turnbull, of the Corps of Topographical Engineers, and Mr. Charles B. Fisk, respectively. No action, however, was taken upon their report.

Immediately after the act of Congress of May 24, 1860, had been approved, the directors of the canal raised money by issuing bonds, purchased land, and engaged the services of Mr. Theodore R. Scowden, the distinguished hydraulic engineer. Under his direction detailed plans were prepared, and the work of enlargement was commenced. The civil war so increased the cost of labor and material that the estimates were greatly overrun, and in 1866, after expending about $1,825,403, the directors were compelled to suspend the work.

On October 1, 1859, Mr. Scowden addressed a letter to Mr. William Hooper, chairman of the joint committees above mentioned, in which he gave his plans for the improvements, premising that they embodied those recommended by those committees and the canal company for passing every description of vessels navigating the Western waters around the falls.

They consisted in widening the water-way from 64 to 100 feet, by removing 36 feet from the south side, and lining both sides with a vertical dry wall, 17 feet high, in fixing the depth of water in the canal at the lowest stage to be 6 feet over "miter sill and all," in removing the abrupt angle in the old canal and substituting a regular easy curve, in providing three passing places, in constructing a guard-gate at the head, in constructing a dam or crib protection of timber and stone, about 600 feet long, extending eastwardly from the head of the canal, and removing all the projecting points of rocks inside of it to protect boats passing in and out of the canal from accident or delay, by being carried with the strong current that sets out over the falls against the ledge of rocks, and in providing a floating boom at the head of the canal to exclude ice and drift; the new locks to be placed 1,500 feet below the old locks and be connected with the old canal by a branch 2,600 feet long, the locks to be two combined, each having a lift of 13 feet, and the rocks at the foot of the canal to be blasted and removed to open a wide and safe channel for going in and out of the canal.

To save expense it was subsequently concluded to reduce the width of water-way to 90 feet.

When the directors were compelled to stop the work, as above stated, in 1866, its condition was as follows, viz:

The masonry work of the new locks, upper guard-gates, and Elm Tree Garden Bridge was finished, excepting the miter-sills of the new locks, the stones for which were on hand but not placed.

The bridges were built.

The timber for the gates was on hand and partly framed.

The machinery for moving the gates was partly finished but not delivered.

The rock ledge below the locks had not been removed.

The lock chambers and space from the locks to the river were almost entirely filled with sediment, and willow trees, 3 inches in diameter, were growing in the locks.

A large portion of the excavation in the branch canal and basin was done, but a heavy bank still separated the new branch from the old canal. A very small part of the earth excavation along the south bank for widening the canal had been made, and the earth excavation for the turnout basin below the Elm Tree Garden Bridge had been almost completed.

At the next session of Congress a "joint resolution providing for the necessary surveys for a ship-canal around the Falls of the Ohio River, for military, naval, and commercial purposes," was passed. It was approved March 29, 1867. It authorized and directed the Secretary of War to cause surveys, with plans and estimates of cost, to be made by an officer of Engineers, for a ship-canal around the Falls of the Ohio River, on the Indiana side thereof, of suitable location and dimensions, for military, naval, and commercial purposes, and also to cause said officer to estimate the expense of completing the Louisville and Portland Canal, on the Kentucky side of said falls, according to the plan on which the said canal company was then progressing with said work.

I was assigned to this duty and began the survey in July, 1867. My report on it is dated February 8, 1868, and may be found in the report of the Chief of Engineers for the year 1868, beginning on page 528.

The bonded indebtedness of the company at this time was $1,567,000, payable in almost equal amounts in 1871, 1876, 1881, and 1886, and bearing 6 per cent. (currency) interest, payable semi-annually.

In my report of the survey I recommended, for the reasons given, not only the immediate enlargement of the Louisville and Portland Canal, but also the immediate construction of a new canal on a proper route on the Indiana side, with a width of 120 feet and new locks 100 by 400 feet. I believed then, and do now, that the radical improvement of these obstructions demanded both, and that the commerce of the Ohio River was entitled to the most generous treatment at this locality.

In order to reduce the expense of rock excavation, and the delay attending it on the two works, and believing that with these two canals constructed it would be unnecessary to risk the dangers of navigating the falls, which were just being increased by the construction of the piers for a railroad bridge, I recommended the construction of two low-water dams; one of these across the river at the crest of the falls, and the other below New Albany. The latter was afterward changed to the head of Sand Island to give more water in the Kentucky channel, and thus obtain the necessary depth there without expensive under-water rock excavation.

With regard to the enlargement of the Louisville and Portland Canal, I followed the plans of Mr. Scowden almost to the letter.

I had known this distinguished engineer by reputation during a considerable period. I had verbal communications with him concerning the work whenever the opportunity presented itself.

The only noteworthy changes I made, after consultation with him, were as follows, viz:

I still further reduced the width of the canal to about 85 feet for the sake of economy. It is now really 86½ feet wide. I built a high-water channel in the river through the outer half of the draw in the railroad bridge, for the accommodation of boats when the river was so high that they could not pass under the bridge through the wide span without lowering their chimneys, and I made the apron or crib dam at the head of the canal 1,800 instead of 600 feet long, and raised it very considerably.

My report of February 8, 1868, of this survey was brought to the attention of Congress, which was then in session.

This Congress, at that session and the next one, failed to pass a detailed river and harbor bill.

An act was passed at its first session, and approved July 25, 1868, which appropriated $1,500,000 for river and harbor works, to be expended under the direction of the Secretary of War, with the proviso that said expenditures should not be applied to any works not mentioned in the bill which passed the House on June 30, 1868. This bill contained a section which appropriated the sum of $450,000 toward completing the Louisville and Portland Canal, in accordance with the plans and estimates made in my report, and assuming the payment of the outstanding canal bonds, with the proviso that all title and right in the canal and its appurtenances be ceded to and vested in the United States, and that the State of Kentucky should relinquish all claim to the government of the same, the canal to be and remain free on and after its completion, except so much toll as should be necessary to operate the same and keep it in repair.

In this distribution of this money the Secretary of War allotted $85,000 to the falls of the Ohio.

The Chief of Engineers, by letter dated July 31, 1868, informed me that this sum was available for expenditure during that working season, if practicable, towards the construction of the two dams proposed by me for the improvement of the falls of the Ohio, and I was directed to proceed at once to carry out the work thus provided for. If it were essential to expedite the work I might do it by hired labor and purchase of material in open market, and also use the telegraph.

Then on August 27, 1868, the Chief of Engineers wrote me a letter in reply to one from me, dated August 22, 1868, in which I recommended, as I had done in my annual report preceding, that a crib-dam be substituted for the one of masonry proposed to be built across the crest of the falls of the Ohio, approving this recommendation.

He then cautioned me to bear in mind that, inasmuch as the act of July 25, 1868, provided that none of the expenditures should be applied to any works not mentioned in the bill which passed the House on June 30 previous, no portion of the allotment could be expended on the Indiana side of the river, *or in view of such work at any future day*, but was solely applicable to work incident *to the extension of the Louisville and Portland Canal.*

My annual report for the fiscal year ending June 30, 1869, contains the following remarks, viz:

> I made no arrangements to commence work on the lower dam, because the amount of money allotted would not warrant it, and also because its construction before the actual extension of the Louisville and Portland Canal would be very injudicious. The

> construction of the upper dam before said extension is completed will be an obstruction to navigation at certain stages for boats too large to pass through the old locks, which are still in use, and is another reason, in addition to the very many already given by me in my previous reports, and by officers who have treated this subject before me, why the proper amount of money necessary to enlarge the body of the old canal, and complete the branch to the new locks, should at once be appropriated.

A letter from the Chief of Engineers, of May 12, 1869, had informed me that $180,000 additional had been allotted by the Secretary of War to the improvement of the falls of the Ohio under the act of April 10, 1869, and that there was no restriction as to the manner in which the appropriation was to be expended.

I was subsequently informed that 1 per cent. of this allotment had been deducted, leaving $178,200. I therefore said, in the annual report above quoted:

> I had already come to the conclusion, long before receiving this authority, and I was sustained in my conclusions by the great experience of the directors of the Louisville and Portland Canal, that the most important thing was first to enlarge and improve the entrance to the head of the canal as far as the upper guard-gates, and whatever balance there might be left to employ in opening the new locks into the main trunk of the canal.

It seems that after the first allotment was made, it occurred to the authorities in Washington that under an organic law of the United States, which is now given in section 355, Revised Statutes, none of it could be legally expended on the canal, because the canal had not been purchased, nor had the legislature of Kentucky ceded unconditional jurisdiction. After the act of April 10, 1869, was passed, the Chief of Engineers, General Humphreys, in order to secure a portion of it for this work, addressed a letter, dated April 15, 1869, to General John A. Rawlins, Secretary of War. This letter may be found in the Report of the Chief of Engineers for 1869, beginning on page 277. After presenting the claim of this work for a portion of the appropriation, he says:

> After a careful examination and consideration of the whole subject, I am decidedly of the opinion that an allotment of some portion of the recent appropriation for rivers and harbors to the enlargement of the canal may be properly made, and I therefore recommend it.

This letter and the whole subject were considered and discussed in Cabinet meeting, and General Humphreys's opinion was approved and adopted by the Administration.

This danger, which seemed at one time to threaten the very life of the work at the start, was thus removed.

In the summer of 1869 the merchants, manufacturers, and steamboat owners of this valley, seeing the slow progress of the work, owing to the small amounts allotted to it, again took hold of this matter with great earnestness and determination.

The river and harbor act of July 11, 1870, appropriated $250,000 for it. By joining hands with those interested in the commerce of the Upper Mississippi, a special act appropriating $200,000 was passed at the next session, and approved January 18, 1871. The river and harbor act of March 3, 1871, appropriated $250,000. With the sums thus allotted and appropriated, the work was pushed as vigorously as possible, and on February 26, 1872, the new locks were opened to commerce, and the largest class of boats could pass through the canal. A great deal, however, remained to be done to complete it according to my original plans.

The river and harbor act of June 10, 1872, appropriated $300,000 for continuing the work, and directed the Secretary of War to report to Congress at its next session, or sooner, if practicable, the condition of the canal, and the provisions necessary to relieve the same from incumbrance, with a view to such legislation as would render the same free to commerce at the earliest practicable period, subject only to such tolls as may be necessary for the superintendence and repair thereof, "*which shall not, after the passage of this act, exceed five cents per ton.*"

By letter from the Chief of Engineers, dated June 19, 1872, I was directed to give official notice to the president and directors of the canal company of the provisions of the last clause of this item, relating to tolls. I did so, and received a reply from Mr. J. F. Speed, president of the company, dated June 27, 1872, that the company would do nothing that might be construed into an acknowledgment that the government could fix the rate of tolls for the use of the canal until the joint resolution of the Kentucky legislature, approved March, 1872, had been complied with by the United States; that the company had been advised that a permission to expend the $300,000 appropriated by the above item in continuing the work on the canal might be regarded as an acknowledgment of a right in the government to fix the tolls at 5 cents per ton, and that therefore justice to the creditors of the company and duty to the State compelled them to decline the appropriation and refuse the use of the canal for its expenditure.

Mr. Speed subsequently wrote, in reply to another letter from me, that the whole appropriation was declined, and that no part of it could be expended on any property of the company.

Previous to this time the directors and I had worked in perfect harmony. They had always met all of my requests with courtesy, and had granted them as speedily as the duties of their trust would warrant.

This matter resulted in a correspondence which was made the subject of a special report by me, dated September 20, 1872, and can be found in the Report of the Chief of Engineers for 1872, beginning on page 448.

I determined to go on with the work under the appropriation, and requested that the district attorney (Col. G. C. Wharton) be ordered to act as my counsel, and prevent the directors from interfering.

Through the good sense of Hon. James Speed, the counsel for the directors, Colonel Wharton, and their associate counsel, it was agreed, after a little preliminary legal skirmishing, to bring the case at once before a judge of the Supreme Court of the United States for decision. The case was tried before Associate Justice Miller, of the United States Supreme Court. He granted an injunction preventing the directors from interfering with the work, but decided that the directors alone, at that time, had the power of regulating the tolls.

This judicial action was satisfactory to all, and removed another danger which threatened the completion of the work.

The river and harbor act of March 3, 1873, appropriated $100,000 for it, and the Secretary of the Treasury was authorized and directed to assume, on behalf of the United States, the control and management of said canal, in conformity with the terms of the joint resolution of the legislature of the State of Kentucky of March 28, 1872, at such time and in such manner as, in his judgment, the interests of the United States and the commerce thereof might require; and the sum of money necessary to enable the Secretary of the Treasury to carry this provision into effect was appropriated. This item also contained a proviso that when the United States assumed control of the canal the tolls thereon should be reduced on vessels propelled by steam to 25 cents per ton, and on all other vessels in proportion.

The joint resolution of the Kentucky Legislature of March 28, 1872, above referred to, was passed at the instance of parties interested in the western commerce. Its object was to enable the government to make the canal free by assuming the debt without being compelled to await the time when the enlargement was completed. It may be found in full in the Report of the Chief of Engineers for 1873, beginning on page 534.

Congress at its next session passed the act providing for the payment of the bonds of the Louisville and Portland Canal Company and taking control of the canal. It was approved May 11, 1874, and in accordance with its provisions the work was transferred to me for and on behalf of the government on the morning of June 10, 1874. This transfer took effect at midnight, when the thirty days specified in the act were at an end. The details of this transfer may be seen in the Report of the Chief of Engineers for 1875, Part I, beginning on page 777.

The river and harbor act of March 3, 1875, appropriated $100,000 to complete the canal according to my original project, and since then no appropriation has been made to carry out the other portion of my plans as given in my report of February 8, 1868.

No one interested in the commerce seems to have taken any further steps before Congress. It may be that those who desired a new canal on the Indiana side were not satisfied with the route selected by me, and therefore took no further interest in it, and that, again, many others did not think that the additional improvement should be placed on that side.

The events which have happened since I made that report have shown more strongly every succeeding year that I was right in making the recommendations that additional canal accommodations should be provided here. But since then I am convinced that these should also be placed on the Kentucky side. We are forbidden, and properly so, from urging appropriations for new works, and are limited solely to giving our views and estimates when asked to do so by proper authority. Until the resolution, which called for this report, was passed, no steps had been taken since the act of May 11, 1874, providing for the transfer of the canal, by any one interested in the commerce of the Ohio River to produce an order and appropriation to begin the additional accommodations which were needed here.

Under the orders contained in the letter from the Chief of Engineers of July 31, 1868, I proceeded with the construction of the apron dam at the head of the canal, and in the period since have several times lengthened, raised, and approved it, and have removed the rock ledge, inside of it, to canal bottom. The masonary dam at the head of Sand Island was completed in 1872, but subsequently abandoned when a very low-water season enabled us to excavate the rock bed in the Kentucky channel to the requisite depth, and at a very economical price. Knowing that the construction of a dam on the crest of the falls would form a serious obstruction to ascending navigation during a few days in each year, and that even these few days, would cause considerable expense and vastly more complaint, if the additional wide canal were not built, I have delayed its completion as long as I could. My various annual reports show that I prosecuted work on it only during low-water seasons, and that I have converted a portion of it into a movable dam. I took advantage of the knowledge and experience gained abroad and in this country concerning these structures. As they are lowered as soon as the river rises, they are not liable to the objections that would be urged by ascending navigation to a fixed dam, and, as will be seen hereafter, I propose eventually to convert the whole into a movable dam.

On the morning of June 11, 1874, the government took control of the Louisville and Portland Canal, and the rates of toll were fixed at 5 cents per ton, registered under tonnage, for steamboats, and for other craft in proportion. These rates were raised to 10 cents in the following January, but subsequently reduced from time to time, so that they finally were reduced 6¼ cents per ton, registered under tonnage, for steamboats, and for other craft in proportion. Finally the canal was made free from all tolls after midnight July 1, 1880, by the act of Congress of May 18, 1880. During the period from June 11, 1874, to midnight July 1, 1880, the government receipts on the canal amounted to $417,069.38 the expenditures to $386,814.02, leaving a balance on hand of $30,255.36, which has been expended on improvements. Of the amount expended by the government, about $120,000 was for permanent improvements. The largest single work which was done under this head was to change the old locks from three chambers to two, so that the capacity of these old locks is now increased to boats 269 feet long. The cost then of the superintendence, management, and ordinary repair of the canal during the six years and twenty days while under government control was about $267,000, or at the rate of about $44,000 per year. The former management had estimated it at $70,000 per annum. A little less than one third of the annual expense of operating the canal is consumed in keeping the canal and locks clear of the mud and silt which high waters deposit in them.

During the progress of the work, and particularly after the government had assumed its control, I was frequently requested by some of the leading falls pilots to expend some of the available money in the improvement of the Indiana Chute. These pilots are a class of men who are experts in taking vessels over the falls. Their business had been seriously impaired by the enlargement of the canal and the reduction of tolls, and it was to their interest to have this natural channel improved. The improvements made at this point had given the trade and commerce of the Ohio River a steady annual increase. In the absence of the additional works recommended by me in my report of 1868, the canal became more and more overcrowded at each coal rise. Anything, therefore, which could give some temporary relief to the existing canal was a benefit to commerce. I therefore, in 1878, asked for and obtained authority to expend a small amount of money in removing some of the worst obstructions in the Indiana Chute. This was done in 1879. But in the absence of any instructions, or even a single inquiry from Congress, I was not authorized to suggest officially the continuance of this experiment.

Finally, on December 22, 1879, the Hon. Albert S. Willis, United States House of Representatives, addressed the Chief of Engineers a letter of inquiry on this subject, which was referred to me, and to which I replied January 12, 1880. In this letter I expressed myself favorable to continuing the work of removing the worst obstructions in this chute.

By the river and harbor acts of June 14, 1880, and March 3, 1881, $10,000 and $50,000 respectively, were allotted from the appropriation for the improvement of the Ohio River, for this work. The season of 1880 was unfavorable for work, and none was attempted, as the greater portion of the small sum of $10,000 would have been wasted in preliminaries. Last season, however, was very favorable and the work was prosecuted with all possible diligence and energy, and considerable good work was done.

In concluding this history I will recapitulate the epochs of the work and financial items.

The original canal was opened to commerce December 20, 1830. The enlarged canal was opened on February 26, 1872. The government assumed control June 11, 1874. The canal was made free of all tolls at midnight July 1, 1880.

The original cost of the old canal was $1,019,277.09. The company afterwards expended about $120,000 on it for improvements and construction. Total cost of the old canal, about $1,140,000.

The company expended on the enlargement $1,825,403. The government, on the enlargement and appurtenances about $1,450,000, and on improvements with canal tolls about $150,000. Total cost of the enlargement about $3,700,000. Total cost of the work, as it now stands, a little over $4,800,000.

The cost of the work to the government was as follows: Original stock purchased, $233,500; appropriated for the enlargement and appurtenances, $1,463,300; canal enlargement bonds assumed, $1,172,000. Deducting cash dividends received, which amounted to $257,778, there remains as the net cost of the work to the government the sum of a little over $2,600,000.

The amount of tolls collected by the canal company from the opening of the original canal in 1830 to the day it was turned over to the government in 1874 was about $5,600,000. The amount collected under government management was $417,069.38; total, a little over $6,000,000; toll collected, in cash, on this work during the period of forty-nine and a half years, or over, $1,200,000 more than its entire cost, and about $3,400,000 more than it cost the government. In view of these figures, no argument nor comment seems necessary.

III.—ADDITIONAL WORKS NECESSARY AT THE FALLS OF THE OHIO RIVER TO COMPLETE THE IMPROVEMENTS THEREOF IN A MANNER TO SERVE THE INTERESTS OF THE COMMERCE OF SAID RIVER.

(*a*.) About 1,300 feet in length additional of the permanent dam, as designed and partially constructed across the Ohio River on the crest of the falls should be converted into movable dams.

(*b*.) The entrance to the head of the canal should be very much enlarged.

(*c*.) Additional canal accommodations around or over these obstructions should be provided.

(*d*.) That portion of the north bank of the existing canal which has thus far been untouched by the work of enlargement should be rectified and new side walls built.

(*e*.) A set of gates should be provided in the branch canal just above the new locks for high-water lockage.

(*f*.) A new lock should be built with a chamber as wide as the present new locks.

(*g*.) A new dry-dock should be constructed.

(*h*.) The basin above the head of the present locks should be enlarged.

IV.—REASONS WHY THESE ADDITIONAL WORKS ARE NECESSARY.

1. *Specific reasons for each case.*

For (*a*) the construction of a dam across the Ohio River on the crest of the falls was a relatively inexpensive but very important part of the original plans which I recommended for the improvement of this locality in my first report, of February 8, 1868. These plans contemplated not only the completion of the enlargement of the Louisville and Portland

Canal, as begun by the company, but also the simultaneous construction of a wider canal, and one provided with larger locks on the Indiana side of the river. This dam would save 3 feet of difficult rock excavation in both, and would save a large sum of money in addition to raising the pool above, and thus benefiting navigation at Grassy Flats Shoals, 16 miles above. Every inch gained on this obstruction was a benefit to navigation. In comparison with these advantages the fact which was well foreseen by me, that it would, on a few days in each year, make the navigation of the falls more difficult, and on some even impossible, could have little weight, since the falls were in process of being more obstructed by the piers of the railroad bridge, and my plan supplied a new and larger canal for commerce, and one that could be used as long as it was needed or desired. This dam was to be continuous, and to have but a single opening in it in the Indiana chute, about 280 feet wide, so that at low stages it would hold up the water of the pool above, and produce a slight overflow, and thus make the timber portion a permanent construction by keeping it continually wet.

But on account of the abnormal and insufficient legislation during the two sessions of Congress immediately after my survey was made, and the organic law of this country relating to the ownership of, and jurisdiction over, sites for public works, those in authority were forced to direct me to begin the work at the wrong end, professionally speaking. Thus the same ill-fortune which has attended the improvement of this locality from the very moment of its inception in 1793, followed it in the technical work which I was about to begin.

Without the new canal recommended by me, I knew that there would be much and just complaint about this cross dam, and I have been prosecuting its construction very slowly, and only in low-water seasons, as my annual reports will show.

In 1872 the question of movable dams, of which the original system was invented in this country by our engineers and then called "bear-trap" dams, but had apparently been forgotten during many years, was again revived. The occasion which eventually led to this revival was the organization of a Board of Engineer Officers to report upon a plan of Mr. F. R. Brunot, of Pittsburgh, for movable hydraulic gates for chutes and locks. It was discovered by the researches made by the members of this Board that our bear-trap dam, which had gone into disuse here, had been noticed and improved upon by foreign engineers, notably of France, and that quite a number of these systems were in successful application in various rivers of Europe. This led to their introduction here.

When, therefore, the season of 1876 developed that the cross-dam had begun to have the effect of making it very difficult, at a certain stage, for ascending navigation in the Indiana chute, and at that stage the canal locks were impassable, I resolved to make a part of the existing portion of the dam movable, and began by placing 300 feet of the system of Boulé in the middle chute. Another way to have overcome the difficulty would have been to raise the middle gates and the walls of the upper chamber, but still another and better way than the latter is to build an additional set of gates, as I will hereafter show. This will prolong the duration of lockage until the falls are navigable, but will not bring back this navigation to its former state. In order to do this it is necessary to reduce the 600-foot opening in the Indiana chute to 280 feet, as the original project required, by two sections of movable dam on each side, and each 160 feet long; to increase the length of the movable portion of the dam in the middle chute to 500 feet, and to make about

800 feet of the permanent dam between the Indiana and middle chutes movable by the introduction of the system of shutters according to Thénard. This improvement will practically convert almost the entire dam into a movable dam, which can be lowered when the river rises, and thus almost completely restore the normal condition of the navigation at such times when it is desired.

Another way of remedying this is the one which is invariably recommended by the falls pilots and boatmen when they have trouble in navigating the Indiana chute, and that is to tear away the entire structure and restore the crest of the falls to its natural condition. If I felt assured that the improvement of this obstacle would not be continued, and my original plans, or some similar ones, would not be executed, I would unhesitatingly approve of this recommendation. But I do not despair of the future, and it is my duty, when in charge of such a work, not only to consider the present, but also the future generations.

It was in this view of my duty that I allowed the coffer-dam for the foundations of a portion of the movable dam on the south side of the Indiana chute to remain in when the river rose last fall. I did not consider the cost of rebuilding this coffer-dam next season so much as the *time* that would be lost in doing so. At that point the room is very restricted and only a limited number of men can work to advantage, and *time* is the important thing. I might waste half a dozen seasons, and the money in building and tearing out this coffer-dam, before a long enough low-water season came to my rescue. I would not be justified in doing this, and hence I allowed this temporary structure to stand. As soon as I get in the foundations for the movable dam and the trestles for it I will remove it. I knew that if certain stages of the river would occur it would cause extra delay and trouble, but I could not allow my line of action to be entirely controlled by that consideration, especially as I was not in the least responsible for the conditions which produced this state of affairs.

The question is often asked by men who have navigated this river during many years, and was once asked me by a very distinguished engineer, why I should be in such a haste to get 6 feet of water in this canal at low stages, when the radical improvement of the river is so far from being complete. There are two reasons for this: The first is that the falls of the Ohio are the worst obstructions on the whole river. The works, to give the navigation the relief which it deserves here, should be of a permanent character, and will cost a great deal of money. The normal depth fixed for the improved Ohio River near this obstruction is 6 feet at low-water. The works here should therefore be arranged for such a depth on general principles. The second reason is of more present importance than the first. Every one who has any knowledge of this river knows that if there were no more water in the canal at the lowest stage than on the bars above and below, it would fail just when every inch of water is needed in it, that is, when the river has risen 4, 5, or 6 feet above the lowest stage. As the river rises the surface of water in the canal rises equally with the surface of the river at the head of the falls. Now, when the river rises above the lowest-water stage and begins to be used by navigation, there is a rise of more than 1½ feet on all the bars above and below for every single foot rise at the crest of the falls and in the water surface of the canal.

If the depth of water in the canal at the lowest stage were therefore left at 3 feet, when there would be 7, 8, or 9 feet in it due to a rise, there would be 9, 10½, and 12 feet, respectively, over the bad bars above and below. There would then be a deficiency in the depth of the canal of

2, 2½, and 3 feet, respectively. But in determining the available depth of water through the canal we should always allow at least 1 foot for mud to prevent delay. So that the real deficiency in the depth of the canal at these stages in comparison with what it should be would be 3, 3½, and 4 feet, respectively, at such times. Now, the deeper boats can load at these stages the better it pays them. To keep, then, a less depth than 6 feet in the canal at the extreme low stage of the river would be a great injury to commerce, and particularly from now until the whole river is improved.

This was the main reason why I wished to get the extra depth at present, even if by doing so I ran the risk of causing trouble at other times; for the stages of water thus provided for generally come after a low-water season when boats have been laid up, and when they are particularly anxious to carry large loads, and when they are apt to get them.

For (*b*). The improvement of the entrance to the canal at the head, as has already been seen, was the very first matter which engaged my attention when I began operations on this work. As much was accomplished as the means at my disposal would permit. It is, however, far from being adequate. This entrance is situated in front of a large part of the lower wharf of the city of Louisville. The local business of this large and growing city increases from year to year, and encroaches upon and interferes more and more each year with vessels desiring to enter the canal. The number of the latter is steadily increasing each year, also, and the state of affairs now is a great deal worse relatively than it was when I began the improvement of this entrance in 1868. A number of very serious and expensive accidents have already occurred, and the danger of their recurrence is increasing from year to year.

For (*c*). In my report of February 8, 1868, on this subject, I recommended an additional canal. If the commerce of the Ohio River could be so regulated that the vessels desiring to pass there would arrive regularly at fixed intervals, the present canal would be abundantly able to accommodate it. The greatest number of vessels that have ever requested lockage through it in a single year were passed through last year. The number locked through during the year was 4,196, and the canal and locks were unoccupied about two-thirds of the time. This is a matter of accurate and absolute record.

But the commerce of the river does not and cannot reach this point in such a regular order. It happens quite often during each year, and especially immediately upon a rise in the river when it has been low for some time, that the vessels arrive above and below in large numbers, and although the lockage is carried on uninterruptedly by night and day, very expensive delays are occasioned, and especially to passenger boats. Another canal was therefore needed when I made my report in 1868, and this necessity has become more and more urgent every year since on account of the steady increase in this commerce. This would not now entirely remove the difficulties, but it would vastly ameliorate them.

In my report cf 1868 I recommended that this additional canal should be located along one of the routes on the Indiana side, and gave, what I then considered, good and sufficient reasons for locating it on that side. I designed this canal to be 120 feet wide, and to be provided with locks 100 by 400 feet. But the system of carrying certain freight, notably coal, in tows composed of a greater or less number of boats and barges, under the guidance of a tow-boat, has assumed such large dimensions, and interferes so much on the present canal with the passenger and ordinary freight vessels, that I consider it best now that a special canal be provided for the exclusive use of such tows, and, for economy of superintendence and management, would locate it in the bed of the river next to the Kentucky shore. I would provide for a width of water-way of 300 feet, and for locks whose dimensions would be the same as those of the one at the Davis Island Dam just below Pittsburgh. The normal tow could then be passed over the falls without being broken up. The bulk of these tows arrive at the canal drawing 7 feet and over, and begin using it when the gauge-reading at the head is 7 feet. At this stage the difference of level between the water surface of the pool above and the one below the falls is a little over 22 feet, and this would be the maximum amount of lift to be provided for by lockage. The embankment to form its sides, as well as the locks, should be of durable but the very plainest and the least expensive masonry.

I recommend that this coal channel be independent of the present canal, because it often happens that the whole canal is filled with coal-boats. This would be the case if the present canal were widened. Nothing could prevent it. In such a case it is impossible to pass a passenger vessel through. We have no means of moving these boats out of the way in any reasonable time, and to do so would cause a great expense, in addition to the most violent complaints on the part of those interested in the shipment of coal.

For (*d*). In the widening of the canal only that portion of the north bank from its head to a few feet below the railroad bridge was touched. Therefore the old side walls and slopes exist on that side from just below the railroad bridge to the head of the old locks. This whole side should be aligned so that it will be set back as far as the side slopes of the basin above the old locks, and new vertical side-walls built throughout. The old walls have begun to fail, and need frequent repairs. They were originally built upon a very economical plan, and for want of funds, I believe. That they never have been replaced on that account, I know. A very desirable additional width of 50 feet will also be given to the canal in this manner, and will enable boats to go through with greater speed.

For (*e*). As the work now stands the new locks of the canal cannot be used for any stage of water higher than 10½ feet on the gauge at the head of the canal, because then the middle lift-gates become submerged; the old locks are not large enough for the vessels which then navigate the river, and the Indiana Chute is not passable for ascending navigation, since the current in it is then still too strong. Unless the river then rises rapidly above that stage or falls below it, navigation at this locality is temporarily suspended. If the river rises rapidly the difference of level between the two pools is reduced, and the velocity of the current so much diminished that vessels can ascend. If, however, the river falls the middle gates can again be used and lockage resumed. This phenomenal stage does not occur very often, and on thirteen occasions when it did take place the river stages varied from 3 feet 9 inches to 7 feet 6 inches inside of twenty-four hours. Yet, when it does occur, no matter how rarely, and the river hangs as it were in this impassable condition, much loss, inconvenience, and complaint ensue, as was actually the case in the latter part of December, 1881. This difficulty, as before stated, can be removed by raising the lock walls of the upper chamber and the middle lift-gates of the new locks. But the latter are already extremely heavy, and an additional increase in their height would be very objectionable in many respects. Another way is by constructing a set of lift-gates in the branch above the new locks, and using the space between these and the upper lift-gates as a chamber for high-water lockage.

This plan is the most economical. It will make lockage passible until the water rises to the top of the upper lift-gates. This is the 19½ foot stage by the gauge at the head of the canal, and corresponds to 17½ feet navigable stage at the head of the Indiana Chute.

For (*f*). If all the improvements which I have enumerated above are made, the whole steamboat navigation of the Ohio River, during good stages, which passes here, will depend upon the stability of either one of the sets of lift-gates of the present new locks. The different parts of an ordinary canal-lock have been at all times and in all countries liable to sudden and unexpected accidents. They are liable to occur at any time on the gates of locks of such large dimensions as 80 by 350 feet, and their great lift. The great loss which might result from the breakage, by accident, carelessness, or design, of either of these gates, should be guarded against, and the best and surest way to accomplish this is by providing a duplicate lock. I would build this lock with a single lift, and of durable but least expensive masonry. This lock should be provided with complete arrangements for being flushed out. The mud and silt are brought down by this river in high stages enormous quantities, and are deposited wherever the velocity of its current is checked. A rise in the river submerges the locks, and it is often after such a rise that the chambers have a deposit of several feet in depth in them, and no lockage can take place until a channel is dredged through it. The present old and new locks are not provided with flushing arrangements, but in designing any new work of my own here I would not neglect any possible arrangement for guarding against mud deposits or providing for their prompt removal.

As the material for building large wooden gates is now becoming scarce in that locality, and would be very expensive if brought there, I think the time has arrived when the gates hereafter to be built should be constructed of iron.

For (*g*). The present dry-dock will only accommodate boats of the size which could use the old locks before I altered them. Very few of such boats now run on this river. A new dry-dock of sufficient capacity to accommodate the largest boats which now use the canal should therefore be built. The old locks will in a short time be of no use for any steamboats, and of no use in assisting coal-tows through. After the independent coal-boat channel which I have suggested is built, I would convert the lower half of these locks into an enlarged dry-dock, as can easily be done at a comparatively small expense.

For (*h*). A much larger basin than now exists at the head of the locks is imperatively needed for the constantly increasing commerce, and to provide the water for the additional lockage without lowering the water in the canal, and to increase the number of possible lockages by having more room to work in. The whole space, if the above-specified improvements are made, included between the south bank of the branch and the north bank of the old canal, and above the two locks and dry-dock, should be converted into a basin, and the temporary shops and storehouses which now stand on that ground should be transferred to the south of the new locks, and be made permanent.

2.—*General reasons.*

In my report of February 8, 1868, I recommended improvements for this locality which I estimated would cost $4,628,500. To justify my recommendation I called attention to the extent, resources, productions, commerce, wealth, and population of the basin of the Ohio and Mississippi rivers, the great importance to the commerce of the Ohio River of having a thorough improvement of the navigation at the falls thereof, and the exceptional bad treatment and neglect which the commerce had received here.

I can only say now that the population, the value of productions and manufactures, and the wealth of the Ohio Basin have steadily increased. Its commerce received a severe blow from the civil war, but since the enlarged canal was opened in 1872 it has revived, and its increase has been in proportion to the increase in population, &c., of its basin. From 1870 to 1880 the increase in its population has been from 13,624,148 to 16,663,201, or about 22 per cent.

The government assumed charge of the canal on June 11, 1847, and since then a record has been kept of the registered undertonnage of every vessel using it. The registered undertonnage gives only about one-half of the real tonnage or load carried. The following table is prepared from this record, and shows, more plainly and concisely than any words at what rate the commerce of this river has increased:

Period.	Registered undertonnage of vessels passed through the canal.
From June 11, 1874, to December 31, 1874, inclusive	274, 365
From January 1, 1875, to December 31, 1875, inclusive	757, 695
From January 1, 1876, to December 31, 1876, inclusive	871, 446
From January 1, 1877, to December 31, 1877, inclusive	999, 610
From January 1, 1878, to December 31, 1878, inclusive	1, 094, 942
From January 1, 1879, to December 31, 1879, inclusive	*778, 889
From January 1, 1880, to June 30, 1880, inclusive	543, 105
From July 1, 1880, to June 30, 1881, inclusive	1, 124, 838

*Canal in use only about one-half the time in consequence of high-water, ice, and low-water.

The increase from the calendar year 1875 to the fiscal year ending last June was, therefore, from 757,695 to 1,124,838 registered undertonnage, or about 48½ per cent.

* * * * * * *

The Ohio River Basin, according to some bulletins relating to the census of 1880 which I have been able to see, still maintains its supremacy over any other of the portions of the great Mississippi Basin. It still yields enormous quantities of iron, steel, coal, petroleum, wheat, corn, oats, salt, and tobacco, and its numerous manufacturing interests are on a steady and healthy increase.

The total internal-revenue collections for the fiscal year which ended June 30, 1881, were over $135,000,000. Of this amount over $87,500,000 were collected in the eight States which, wholly or in part, lie in this basin.

No toll has ever been paid on the Des Moines and Rock Island Rapids in the Upper Mississippi, and Congress has appropriated $5,955,350 to improve them, against $2,600,000 expended here.

In order to improve the navigation to Lake Superior, the government in 1852 gave the State of Michigan 750,000 acres of land and the right of way to build a canal around the falls of Saint Mary's River, and has appropriated $2,616,000 since for its enlargement and the improvement of the river.

As the work now stands, it is inadequate to serve the interests of the commerce of the Ohio River, and it will become more and more so each year until the additional works suggested by me are completed.

V.—RECORDS.

Since the government has had charge of the operation and care of this canal, a great many records have been kept, and as some of them are of general interest, I will here present them in condensed form:

1. *Number of days per annum when a canal is needed.*—The canal was closed by high-water sixty days in 1875, fifty-four in 1876, twenty-nine in 1877, twenty-five in 1878, fifty-one in 1879, fifty-seven in 1880, and forty-one in 1881. Total in seven years, three hundred and seventeen days, or on an average of forty-five and two-sevenths days per annum. A canal is therefore needed, on an average, ten and one-half months in the year.

2. *Mud and silt brought down by high-water.*—The average quantity of mud carried here by high-water is 200 pounds to 100 cubic feet of water, or about one thirty-second in weight. The total amount of deposit dredged here during the six years included between the 1st of January, 1876, and the 1st of January, 1882, was 447,772 cubic yards, or an average of 74,629 cubic yards per annum. Of this, 299,702 cubic yards were removed from the canal and 148,070 from below the locks.

3. *Delays.*—Delays occur whenever a great number of vessels arrive at the locks at about the same time, notwithstanding the fact that lockage is then carried on uninterruptedly day and night. The greatest of these occur on a so-called coal rise; that is, when the river rises sufficiently to liberate large numbers of coal tows at Pittsburgh and below. Since the government has had charge of the canal these coal rises have averaged five in number per annum. The averaged time required to lock everything through on such occasions is about six days. The greatest number of lockages made with the new locks in twenty-four hours has been twenty-one. At each lockage of the new locks from two to three coal boats or six coal barges are passed through. One coal boat or four coal barges are locked through the remodeled old locks at one lockage. Aside from the delay of the coal fleets, from eighteen to twenty-four passenger steamers are delayed on such occasions. The average delay to each one has been fourteen and a half hours. The average cost of each day's delay to them is $200 per steamer.

VI.—ESTIMATES.

FOR (*a*) IMPROVEMENT ON FALLS.

Completing the removal of the worst obstructions in the Indiana Chute.	$129,400 00
300 feet extension of Boulé dam in Middle Chute	13,800 00
320 feet of movable dam in Indiana Chute	26,400 00
800 feet Thénard shutters	50,400 00
Contingencies, superintendence, &c	22,000 00
Total	242,000 00

FOR (*b*) ENLARGING ENTRANCE TO CANAL.

Earth excavation	$64,800 00
Slate excavation	48,330 00
Moving side wall	11,354 40
Contingencies, superintendence, &c	13,831 60
Total	138,316 00

FOR (*c*) INDEPENDENT COAL CANAL.

Earth excavation	$268,530	00
Rock excavation	1,150,452	00
Removing old walls	21,688	00
Retaining walls on north side, east of railroad bridge	20,000	00
Retaining walls on north side, west of railroad bridge	200,000	00
Lock masonry	997,800	00
Gates and machinery	100,000	00
Movable dams	32,000	00
Steamer and dredges	30,000	00
Contingencies, superintendence, &c	282,047	00
Total	3,102,517	00

FOR (*d*) ALIGNING NORTH WALL OF CANAL, WIDENING THE PRESENT CANAL 50 FEET, AND BUILDING NEW SIDE WALLS.

Earth excavation	$180,200	00
Rock excavation	288,400	00
Removal of old wall	31,000	00
Removal of paving	28,100	00
New retaining wall	201,200	00
New bridge at Eighteenth street	30,400	00
Purchase of land	5,000	00
Contingencies, superintendence, &c	76,430	00
Total	840,730	00

FOR (*e*) SET OF GATES IN BRANCH ABOVE NEW LOCKS, TO PROVIDE HIGH-WATER LOCKAGE.

Earth excavation	$1,110	00
Rock excavation	200	00
Removing retaining wall	1,560	00
Coffer-dam, pumping, &c	1,000	00
Masonry	36,980	00
Gates and machinery	7,500	00
Contingencies, superintendence, &c	4,845	00
Total	53,195	00

FOR (*f*) NEW LOCK PARALLEL TO THE PRESENT NEW LOCKS, AND 400 FEET LONG AND 80 FEET WIDE.

Earth excavation	$66,600	00
Rock excavation	160,000	00
Slate excavation	90,000	00
Masonry	385,500	00
Iron gates	125,700	00
Gate machinery	10,000	00
New bridge to Shippingsport	34,200	00
New office, dwelling, and stable	8,000	00
Contingencies, superintendence, &c	88,000	00
Total	968,000	00

FOR (*g*) NEW DRY-DOCK TO ACCOMMODATE THE LARGEST VESSELS.

Earth excavation	$28,600	00
Slate excavation	22,300	00
Masonry	79,000	00
Paving	13,200	00
Iron gates and machinery	14,000	00
New bridge to Shippingsport	20,520	00
Filling old lock-chambers	21,500	00
Contingencies, superintendence, &c	19,912	00
Total	219,032	00

FOR (*h*) ENLARGING THE BASIN AT THE HEAD OF THE LOCKS.

Earth excavation	$132,600 00
Slate excavation	113,300 00
Removing old paving	1,400 00
Removing old walls	12,600 00
Removing old lock-walls	7,400 00
New retaining-walls	42,000 00
New workshops and storehouses	10,000 00
Contingencies, superintendence, &c	31,930 00
Total	351,230 00

RECAPITULATION OF ESTIMATES.

(*a*) Improvement on falls	$242,088 00
(*b*) Enlarging entrance to canal	138,316 00
(*c*) Independent coal canal	3,102,517 00
(*d*) Widening the old canal and aligning the north bank	840,730 00
(*e*) Extra set of gates in branch for high-water lockage	53,195 00
(*f*) New lock parallel to present new locks	968,000 00
(*g*) New dry-dock	219,032 00
(*h*) Enlarging basin at head of locks	351,230 00
Total	5,915,108 00

The order in which the work should be executed is as follows, viz:

Extra set of gates in branch for high-water lockage	$53,195 00
Improvement on falls	242,088 00
Enlarging entrance to the canal	138,316 00
Independent coal canal	3,102,517 00
New lock parallel to present new locks	968,000 00
New dry-dock	219,032 00
Widening old canal and aligning the north bank	840,730 00
Enlarging basin at head of the locks	351,230 00

I have attempted to make these estimates sufficiently large to cover the expense of delays due to inadequate appropriations. If the latter could be made at the rate of, say, $500,000 for the first year, $1,000,000 for each of the next four years, and $500,000 for each of the next two years, the work could undoubtedly be completed in an economical and business-like manner, and at a saving of about $500,000. At all events, there should be an immediate appropriation of $500,000 to do the work included in the first three items as soon as it can possibly be done. In a few years the present wooden gates of the new locks must be replaced by iron gates, and this will cost about $125,000, but would not, under existing laws, require a special appropriation, since this item would natually come under the head of operation and care of the canal.

I transmit herewith three sheets of tracings to illustrate this report.

Sheet I gives a map of the Falls of the Ohio River, on which the proposed improvements are indicated, and also a map on a small scale to show the position of these obstructions in relation to the Mississippi and Ohio valleys.

Sheet II shows the condition of the Louisville and Portland Canal on July 1, 1867.

Sheet III shows the condition of this canal on January 1, 1882.

These three sheets are intended to form a part of this report, and should, if possible, be photolithographed and form a part of whatever printed copies may be published.

Very respectfully, your obedient servant,

G. WEITZEL,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

X 2.

OPERATING AND MAINTAINING THE LOUISVILLE AND PORTLAND CANAL.

The past year has been remarkable for the number and duration of the high stages of the river. The average annual period during which the canal was required by the commerce of the Ohio River during the previous seven years was about three hundred and twenty days. During the past year it was required only two hundred and fifty days, and was closed one hundred and fifteen days on account of high water only.

The same policy which has heretofore been pursued has been followed during the past year. Repairs have been made in the order of necessity, and as far as possible they have been made permanent.

The canal proper is in good condition, except the original paved slopes and side walls of the old canal on the north side. These now need frequent repairs.

The amount needed during the next year to make the permanent repairs which are necessary is $11,500. Of this amount $2,500 will be required for new upper gates of the old locks, $2,000 for the new boilers for the gate engines on the new locks, $5,000 for new upper gates of the new locks, and $2,000 for a new cottage for the tender at the Eighteenth street swing bridge.

During the year 3,964 vessels have passed through the canal, whose registered undertonnage amounted to 904,343 tons.

In addition to the general merchandise which they transported, 11,348,000 bushels of coal, 25,800 tons of iron ore, and 58,850 barrels of salt were carried by them.

The receipts from dredging for private parties, use of dry-dock, and rents during the year amounted to $243.75. This has been placed to the credit of the Treasurer of the United States, since no other disposition of it has yet been provided for by legislation.

The total amount expended during the year was $66,533.65. Of this amount $7,615.18, the sum remaining as a balance from the improvement fund of the previous year, was expended in part payment of the cost of construction of the apron-dam at the head of the canal; the sum of $16,216 was expended on the same improvement, and on the reconstruction of lock-gates and other works on the new and old locks; leaving the cost of operating the canal about $43,000, or near the usual average.

The amount estimated as necessary for operating and maintaining the canal for the fiscal year ending June 30, 1883, is $51,720, of which $40,220 is intended for operating and minor repairs and $11,500 for permanent repairs.

For the fiscal year ending June 30, 1884, it is probable that $40,220 will be needed for operating and minor repairs, and a new set of boilers for the tow-boat.

The expenditures for permanent repairs since the government took charge, *i. e.*, during a period of eight years and nineteen days, have been about $167,000.

The appended report of Mr. P. J. Schopp, my assistant, on the improvement and superintendence of the canal, gives further details.

REPORT OF MR. P. J. SCHOPP, ASSISTANT ENGINEER AND SUPERINTENDENT OF THE CANAL.

LOUISVILLE, KY., *July* 1, 1882.

SIR: I have the honor to submit herewith report upon operating and care of Louisville and Portland Canal for the fiscal year ending June 30, 1882.

During two hundred and fifty days in the year, the canal was in operation, and closed one hundred and fifteen days on account of high water. The large locks were closed for fifteen days, during which time vessels navigating the canal passed through the remodeled old locks. Navigation through the canal was not interrupted during the low water season.

During the fiscal year 3,964 vessels, representing 904,343 tons undertonnage, 11,348,000 bushels of coal, 25,800 tons of iron ore, and 58,850 barrels of salt passed through the locks.

The apron-dam at the entrance to the canal, which had been seriously damaged by ice, was reconstructed and repaired.

The waste-weir close to the retaining wall on the north side has been done away with and closed up, and the apron-dam raised to the 12-foot mark on the upper gauge for a distance of 326 feet. The entrance and exit of boats is now much safer and less hazardous, though this part of the improvement is not yet finished. It will be completed as soon as the water falls sufficiently to commence work, the material being all on hand.

At a distance of 660 feet from the end of the north retaining wall a section of movable dam of 100 feet length (Thénard system) has been constructed in place of a permanent crib-dam. Years of observation had shown the necessity of a larger opening than the old waste-weir. The movable Thénard shutters may be lowered in case of a large run of drift-wood, and particularly in an ice run they will be of great service, preventing the wedging in of large masses of ice into the narrow mouth of the canal. Beyond this movable dam the damaged part of the apron-dam (of which the movable dam is part) has been repaired to its original height.

Along the canal the old retaining wall on the north side had to be repaired in several places, and also the fence running the entire length on the south side from the railroad bridge to the locks.

The dry-dock has been provided with a new set of gates and is now in good order. When the stage of water permitted, the dock was almost exclusively occupied by vessels belonging to the canal which needed repairs.

The old locks did good service during low water and while the new locks were under repairs. Subsequently, however, the upper lift-gates, which were old and had not been replaced under the present management, gave way, necessitating the construction of a new set of gates. These gates will be finished in a few months.

At the new locks the projected improvements were continued. New hollow quoins for lower-gate recesses were placed previous to the erection of iron suspension columns.

The old lower gates being in a dilapidated condition, preparations for building a new set had been made last year. The new gates were built at the canal shops during the fiscal year, and are now finished and lying in the basin above the locks, ready to be hung as soon as practicable.

The rotten middle gates were replaced by a set of new gates during the time the locks were closed for repairs.

Columns for their suspension had been previously erected. The plan adopted of carrying part of the weight of these necessarily very heavy gates by suspension works very satisfactorily. The gates move with ease, and are operated with an average pressure of steam of not more than 15 pounds to the square inch.

Timber and iron-work for a new set of upper gates for the new locks have been ordered and most of the heavy iron-work has been prepared. These gates will be built at the canal shops during the next fiscal year. The iron columns to suspend them are also on hand.

New boilers for the lock machinery have been contracted for.

A large pump to feed the boilers, and at the same time to act as fire-pump by pumping the water through laid pipes to the top of the slope in the vicinity of the buildings, has also been placed at the middle gates on the north side. The pump, too, is used to clean the lock-walls of sediment and does good service. For the latter purpose a similar pump should be placed on the south side.

Extensive repairs were needed in the dredge department during the past and will be needed during the next fiscal year. The mud-scows built six years ago were to a great extent rotten. Three of them have been thoroughly repaired and the fourth is in the dry-dock. The tow-boat Walker Morris needs an overhauling, and dredge No. 2 must soon be put on the ways for extensive repairs.

During the fiscal year dredge No. 2 received a new boiler.

The Eighteenth Street Bridge across the canal, over which the traffic is considerable on account of the cement mills and stone-blasting for the streets, has been repaired, partly new joists and new decking being placed.

No new machinery has been added to the machine shops. The frame buildings as well as the fences around the locks have been whitewashed, and the office and dwelling near the locks been painted. Trees have been planted and the grounds kept in neat appearance.

No provisions have been made to build a bridge-tender's cottage. The present one has been somewhat repaired.

The number of regularly employed men is thirty-eight.

Charges for extra work of dredges, use of tow-boat and dry-dock were the same as in former years, viz, $2.50 per hour for dredging; $2.50 for use of steam pump; for towing, harbor rates; for the use of dry-dock, $15 for first and $10 for each subsequent day.

The receipts from extra work of dredging, use of dry-dock and tow-boat, and rent for dwelling and cement-pipe works during the fiscal year amount to $243.75.

The total expenditures for the fiscal year were $66,533.65, of which $7,615.18 have been for permanent improvements.

During the next fiscal year new upper lift-gates for old canal will be finished and a set of new upper gates for new locks will be built at the canal shops, besides such repairs as prove necessary during the year.

My estimate submitted last year for the fiscal year ending June 30, 1883, needs correction. The employment of an additional lock-hand was a necessity, and consequently the regular pay-roll will be increased $600. The item "general repairs" must also be increased on account of repairs to tow-boat and dredge No. 2.

With the building of new upper gates for old and new locks, cottage, and boiler for tow-boat, the permanent improvements will have been completed and the work be in such a condition that for some time, provided no unforeseen accidents occur, the expenses will only be for operating and care, in a round sum about $40,000 in a year, exclusive of any amount that may be appropriated for works recommended by you in special report dated February 10, 1882.

Special estimates for the fiscal years 1882–'83 and 1883–'84 are submitted.

Tables for comparison with former years are annexed. The tables were made up from records kept in this office.

Very respectfully, your obedient servant,

PHILIP J. SCHOPP,
Superintendent Louisville and Portland Canal.

Maj. G. WEITZEL,
Corps of Engineers, U. S. A.

Approximate estimate of expenditures on the Louisville and Portland Canal for the fiscal year ending June 30, 1883.

Permanent improvements:		
New upper gates, old locks	*$2,500	
Boilers for gates engines	*2,000	
		$4,500
New upper gates, new locks	5,000	
Cottage for bridge-tender	2,000	
		7,000
Operating and care:		
General repairs	4,800	
Miscellaneous, office, fuel, oil, &c	4,700	
Extra labor	1,500	
Regular pay-roll	29,220	
		40,220
Total		51,720

Approximate estimate of expenditures on the Louisville and Portland Canal for the fiscal year ending June 30, 1884.

Operating and care:	
A new set of boilers for tow-boat	$2,000
General repairs	2,800
Miscellaneous, office, fuel, oil, &c	4,700
Extra labor	1,500
Regular pay-roll	29,220
Total	40,220

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*From last year's estimates, the work not being finished

Financial statement for fiscal year ending June 30, 1882.

Receipts.	Amount.	Expenses.	Amount.
Rents	$106 25	Lockage department	$42,556 95
Dry dock	30 00	Dredge department	16,361 52
Dredging	107 50	Improvement	7,615 18
Total	243 75	Total	66,533 65

Detailed statement of expenditures on the Louisville and Portland Canal during the fiscal year ending June 30, 1882.

Month.	Lockage department.				
	Labor.	Purchases and repairs.	Lights.	Office expenses.	Total.
1881.					
July	$1,641 32	$903 83	$17 92	$24 33	$2,587 40
August	2,288 12	3,445 68	16 45	4 50	5,754 75
September	1,491 65	1,853 41	17 59		3,362 65
October	4,253 96	1,581 74	10 59	25 40	5,871 69
November	3,329 20	1,872 70	18 71		5,220 61
December	2,256 00	958 97		51 05	3,266 02
1882.					
January	1,922 74	2,049 68	18 63	27 00	4,018 05
February	1,800 75	178 00	90	58 30	2,037 95
March	1,911 83	592 39	9 36	18 10	2,531 68
April	1,770 00	1,010 79	16 82	4 50	2,802 11
May	1,653 37	737 65		25 00	2,416 02
June	1,643 34	1,031 16	8 52	8 00	2,688 02
Total	25,962 28	16,216 00	135 49	243 18	42,556 95

Month	Dredge department.			Improvements.	Grand total.
	Labor.	Purchases and repairs.	Total.		
1881.					
July	$835 00	$634 68	$1,469 68	$1,733 30	$5,790 38
August	835 00	364 56	1,199 56	413 57	7,367 88
September	835 00	325 79	1,160 79	5,458 73	9,982 17
October	835 00	282 01	1,117 01	9 58	6,998 28
Nevemcer	828 33	235 84	1,064 17		6,284 78
December	835 00	1,304 25	2,139 25		5,405 27
1882.					
January	835 00	99 45	934 45		4,952 50
February	835 00	267 28	1,102 28		3,140 23
March	835 00	18 02	853 02		3,384 70
April	847 00	1,110 45	1,957 45		4,759 56
May	835 00	1,206 29	2,041 29		4,457 31
June	835 00	487 57	1,322 57		4,010 59
Total	10,025 33	6,336 19	16,361 52	7,615 18	66,533 65

Statement of boats passed through the canal during the fiscal year ending June 30, 1882, with number and cost of lockages and amount and cost of dredging.

Month.	Number and undertonnage of steamboats, barges, &c., passed through the locks.											
	Passenger boats.		Tow-boats.		Model barges.		Square barges.		Small boats, rafts, &c.	Government boats.	Total.	
	Number.	Undertonnage.	Number.	Undertonnage.	Number.	Undertonnage.	Number.	Measured capacity.			Number.	Tonnage.
1881.												
July	90	38, 414	49	5, 328	39	9, 898	154	34, 796	11	9	352	88, 436
August	78	23, 058	50	4, 144	29	7, 970	115	21, 391	16	2	290	56, 563
September	42	4, 245	30	1, 858	4	616	86	10, 345	15	...	177	17, 064
October	51	10, 614	76	3, 716	4	623	156	20, 294	26	1	314	35, 247
November	79	31, 214	100	10, 482	61	18, 005	366	92, 168	30	10	646	151, 861
December	52	24, 182	60	5, 627	28	8, 168	301	46, 334	13	5	459	84, 311
1882.												
January	6	3, 279	4	395	1	157	9	1, 872	......	3	23	5, 703
February	8	3, 283	6	1, 182	6	1, 738	43	14, 746	1	1	65	20, 949
March	17	8, 582	32	3, 649	15	5, 189	123	29, 914	2	....	189	47, 364
April	98	42, 192	111	13, 346	56	15, 913	408	111, 327	28	5	706	182, 778
May	46	16, 954	50	7, 441	32	8, 858	313	101, 959	5	3	449	135, 212
June	50	18, 135	42	6, 130	25	6, 829	171	47, 758	6	....	294	78, 852
Total	617	224, 152	610	63, 298	300	83, 964	2, 245	532, 929	153	39	3, 964	904, 343

Month.	Number of lockages.	Cost per lockage, excluding dredging.			Dredging, cost per cubic yard.	Total cost.		
		Cost per lockage.	Cost per boat.	Cost per ton.		Per lockage.	Per boat.	Per ton.
1881.				*Cents.*	*Cents.*			*Cents.*
July	177	$14. 618+	$7. 35 +	2. 925+	10. 89 +	$22. 92 +	$11. 526—	4. 587+
August	147	39. 148—	19. 844—	10. 174+	14. 83 +	47. 308+	23. 98 +	12. 294
September	90	37. 363—	18. 988+	19. 70 +	11. 48 +	50. 26 +	25. 556+	26. 52 +
October	160	36. 698+	18. 699+	16. 658+	63. 92 +	48. 679+	22. 257	19. 82 +
November	261	20. 002+	8. 081+	3. 437+	31. 46 +	24. 08 —	9. 73 —	4. 13 +
December	150	21. 773+	7. 115+	3. 92 +	68. 65 +	36. 035+	11. 776+	6. 411+
1882.								
January	13	309. 08 +	174. 698—	70. 278—	....	380. 96 —	215. 326+	86. 84 +
February	28	72. 784—	31. 353—	9. 72 +	35. 81 +	112. 151+	48. 81 +	14. 99 —
March	69	36. 69 —	13. 389+	5. 347+	....	49. 058+	17. 903+	7. 146+
April	284	9. 866+	3. 969—	1. 533+	13. 41 +	16. 759—	6. 741+	2 603+
May	181	13. 348+	5. 38 +	1. 787—	26. 08 +	24. 626	9. 927+	3. 29 —
June	119	22. 588+	9. 143+	3. 409 -	7. 928+	33. 701+	13. 641+	5. 086+
Total	1, 679	....	....	....	....	....	....	....

Abstract of bids received and opened by Maj. G. Weitzel, Corps of Engineers, U. S. A., on June 12, 1882, for furnishing coal for use on the Louisville and Portland Canal.

Number of bids.	Names of bidders.	Residence of bidders.	Pittsburgh coal delivered at office Louisville and Portland Canal, 1,000 bushels, more or less.	Raymond City coal delivered at machine-shops Louisville and Portland Canal, 500 bushels, more or less.	Pittsburgh coal (Risher) delivered at blacksmith shops Louisville and Portland Canal, 900 bushels more or less.	Pittsburgh coal delivered at engine-houses Louisville and Portland Canal, 8,000 bushels, more or less.	Raymond City coal delivered on barge Louisville wharf, 20,000 bushels, more or less.
			Per bush.	*Per bush.*	*Per bush.*	*Per bush.*	*Per bush.*
1	Byrne & Speed	Louisville, Ky	....	$0 11	$0 11	$0 11	$0 09¼
2	Hugh O'Donnell & Co	Louisville, Ky	$0 11¾	11¾	11¾	11¾	....
3	Austin H. Dugan & Co	Louisville, Ky	....	....	....	13¼	9¾

Abstract of bids received and opened by Maj. G. Weitzel, Corps of Engineers, U. S. A., on May 27, 1882, for furnishing two steam boilers for the Louisville and Portland Canal.

Number of bids.	Names of bidders.	Residence.	Price for two steam boilers.
1	Robert W. Ramsey	Louisville, Ky	$1,090
2	M. Zier & Co	New Albany, Ind	1,350

WORK OF DREDGING DEPARTMENT AND EXPENDITURES ON IT FOR THE FISCAL YEAR ENDING JUNE 30, 1882.

Time dredging days	175½
Time lost:	
By high water do	89
By Sundays and holidays do	59
By repairs do	11½
By other labor do	30
Cubic yards excavated during year	82,198
Cubic yards excavated per day	468.36
Salaries:	
For the year	$10,025 33
Per day	27.466
Cost repairs:	
For the year	6,336 19
Per day	18 18
Cost for dredging only	8,110 87
Cost per working day of actual dredging	46.216—
Cost per cubic yard excavated	0.9868+

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